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INITIAL REPORT ON A STUDY TO PLAN DEVELOPMENT AND IMPLEMENTATION OF A CONNECTICUT LIBRARY RESEARCH CENTER.

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Performed under the guidance of the Connecticut State Library and the Connecticut State Library Research Advisory Committee, this study includes (1) a survey of Connecticut librarians and library users to evaluate the need for a Library Research Center, (2) a design concept for a proposed operational system and a plan for its implementation, and (3) estimates of the costs of implementing and operating the system and the requirements for space and personnel. It is concluded that a need exists in Connecticut for a center such as that proposed, offering services which should include at least bibliographic searching, a document locating service, and centralized control, coordination, and dissemination of catalog data. In addition, printed products such as book catalogs and current awareness lists should be provided. The automation of these services is feasible, and, assuming funds can be made available, implementation should start in July, 1967. The outline of a further study program for the detailed design of the initial system, which should be completed before implementation begins, is included. (Author/JB)

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A STUDY SUPPORTED BY
THE CONNECTICUT RESEARCH COMMISSION

FOR

THE CONNECTICUT STATE LIBRARY

LI 000975

United Aircraft Corporate Systems Center
U
DIVISION OF UNITED AIRCRAFT CORPORATION
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FARMINGTON, CONNECTICUT 06032

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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INITIAL REPORT

ON

A STUDY TO PLAN DEVELOPMENT AND IMPLEMENTATION OF A CONNECTICUT LIBRARY RESEARCH CENTER

A STUDY SUPPORTED BY
THE CONNECTICUT RESEARCH COMMISSION
UNDER AWARD RSA-66-4

FOR

THE CONNECTICUT STATE LIBRARY

September 26, 1966

UNITED AIRCRAFT
CORPORATE SYSTEMS CENTER
Division of United Aircraft Corporation
Farmington, Connecticut

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SUMMARY

In accordance with United Aircraft Corporate Systems Center Proposal SCP 6664, dated May 6, 1966, an initial study to plan development and implementation of a Connecticut Library Research Center has been completed. The study has been supported by Connecticut Research Commission Award RSA-66-4, and the work has been performed under the guidance of the Connecticut State Library and the Connecticut State Library Research Advisory Committee.

The report includes descriptions of a survey of librarians and library users in Connecticut performed for the purpose of evaluating the need for a Library Research Center and the services which should be offered, a design concept for the proposed operational system, and a plan for its implementation. In addition, for planning purposes, estimates of the costs of implementing and operating the system and of the requirements for space and personnel are included.

It is concluded that a need exists in Connecticut for a center such as that proposed, offering services which should include at least bibliographic searching, a document locating service, and centralized control, coordination, and dissemination of catalog data. In addition, printed products such as book catalogs and current awareness lists should be provided. The automation of these services is feasible, and, assuming funds can be made available, implementation should start in July 1967. The outline of a further study program for the detailed design of the initial system, which should be completed before implementation begins, is included.

1. PURPOSE AND SCOPE

The purpose of the study described in this report has been to evaluate the need for a Connecticut Library Research Center, to determine the services which should be furnished, to describe a concept for the design of the Center, and to outline a plan for the implementation of an initial system.

The overall program of establishing a library center has been divided into three major time periods, called Phase I, Phase II, and Phase III. Phase I covers an initial period of implementation, with restricted service to the users of the system, during the first two years. By a process of evolution, the fully operational system of Phase II comes into being within the State during the subsequent two or three years. Following that, in Phase III, service may become more comprehensive by integration of the State system into anticipated national library networks. The study described herein is concerned principally with Phase I, but contains also a general description of the objective system of Phase II, and includes a rather gross estimate of the annual cost of operation during that phase. With regard to Phase I, the principal objective has been to outline the initial steps which should be taken in getting an active program started and to estimate the associated costs and personnel requirements. Phase III operation is dependent on planning at the national level, and the present requirement is limited to maintaining cognizance of the development of those plans.

A basic requirement of the study has been to define the scope of the system in terms of the kinds of library information which should be included, the users who should be served, and the services to be provided. While the stated aim is to improve the speed and completeness in locating and making available the information resources of the State to those engaged in research activities, it is obvious that this statement of an objective is subject to many different interpretations. For example, while the term "research" may in some minds be limited to postgraduate scholarly investigations, either in an academic or industrial environment, there is some justification for considering any use of library materials as research. It is felt that, while constraints must be imposed by the bounds of economic and technological feasibility, the imposing of artificial limits on the inclusion of either resource materials or categories of users should be avoided.

With these thoughts in mind, an evolutionary development program for an automated system is proposed, starting with a relatively small data base and limited service. From a small and eminently practical start, the system can grow quite rapidly until, within a few years, effective service with considerable breadth of scope may be offered to essentially all prospective users within Connecticut.

Initially, the bibliographic reference and library holdings data stored in the Center will be limited to recent acquisitions, starting with books but soon to include an increasing range of periodical titles and their contents, and reports. The prospects of increasing the scope to embrace back holdings must be examined in future studies. No limits on the coverage with regard to subject fields are proposed. The automated services to be provided will include at least: searching of bibliographic reference data through one or more kinds of descriptors, such as author, title, subject headings, publication date, and source; locating specific documents, and specifying their accessibility, from a mechanized list of holdings of libraries within the State; and centralized control and coordination of cataloging activities and the sharing of the resulting output by all Connecticut libraries desiring this service. In addition, the feasibility and desirability of disseminating printed material in the form of book catalogs and current awareness lists, at least on an interim basis, will be determined. With regard to user groups to be served by the system, there appear to be no valid reasons for excluding any person, of any age or educational level, who has the intellectual capacity needed to make effective use of the system.

2. INTRODUCTION

The 1965 session of the Connecticut General Assembly enacted Public Act No. 490 which instructs the State Library Committee to "engage in planning for . . . . the establishment of a research center to facilitate the most effective use of materials in public, university, professional and industrial libraries." With this objective in mind, the State Library formed a Research Advisory Committee in the fall of 1965, composed of 38 representatives of leading public, academic, and special libraries and of the general public, with a working subcommittee of seven members. In May, 1966, United Aircraft Corporate Systems Center (UACSC) was selected by the Research Advisory Committee to make an initial examination of the problems associated with establishing a system which would improve speed and completeness in locating and making available to all who need them the informational resources within the State. Application for support was made by the Committee to the Connecticut Research Commission, and funding was arranged by the Commission to cover the first four months of the proposed study. The first part of the study, which is now complete, is aimed towards the generation of information in support of a proposal for initial implementation of a center, for submission to the General Assembly early in 1967. A favorable reception of this proposal and appropriation of initial funding could result in a start on the project in July 1967. To this end, this report describes the results of a survey of user needs, the services which the center should provide, a conceptual design of a system which would offer these services, a plan for implementation of the center, planning data for the first installation, and an outline of additional tasks which must be performed before implementation begins.

Library Problems

The problems faced by librarians in trying to provide the best possible service to their patrons are widely recognized.[1, 2, 3, 4*] They stem to a large extent from the fantastic rate of growth of publication of books, journals and other serials, reports, and other items. Compounding the problem of keeping up with this flood of published material is the widespread shortage of trained library staff, particularly those with capability and experience in the general field of bibliographic retrieval. Many libraries in the State, as elsewhere, are at present trying to operate below their funded staff strength, simply because they cannot find librarians with adequate training to fill the vacancies which exist. However, even if staff could be found and funds were available to increase staff sizes, there are problems which cannot be solved with existing resources. For example, while the traditional card catalog constitutes an adequate tool for control and searching of a collection of reasonable size, it becomes almost unmanageable with a really large collection, particularly as a means of bibliographic searching by subject where the collection covers a wide range of subject areas. Staff increases do little to alleviate a problem of this kind. Also, in the smaller libraries, the bibliographic tools are not available, and it would not be reasonable to provide funds for their purchase. Even in the largest libraries, the means for bibliographic searching do not exist in all subject fields.

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*Numbers indicate references listed in Section 9.

Accompanying the rapid growth of published materials, library holdings have increased at comparable rates where budgets permit, and the demands for service from the library patrons have also risen sharply. In addition, the level of service demanded by specific segments of the population is increasing. For example, undergraduate university students are expecting service which compares in its level of sophistication with the demands of the graduate student of a generation ago. The extent to which present-day bibliographic controls can satisfy the need is limited in many areas where the demand is high. Even with the best card catalog and subject-related indexes and with the assistance of an expert reference librarian, subject searches are likely to retrieve an excessively large list of references, and no means exists for rapidly narrowing the search to those items which are truly pertinent. The attention which is currently being devoted to these problems within the library community, the academic community in general, and in government and industry testifies to the urgent need for solutions.

The Promise of Automation

The application of techniques of automation towards the alleviation of some of the problems faced by libraries is receiving increasing attention within the libraries themselves, and in government and industry.[5-14] The well-known ability of electronic computers to perform routine repetitive tasks, freeing professionals to spend their time more profitably on the specialized work for which they are trained, offers considerable potential in the more routine procedural day-to-day operations of running the library. For example, computers can perform many of the record-keeping tasks involved in ordering, acquisitions control, circulation control, serials control, and other areas. In the present context, it is felt that automation can do far more than serve the individual libraries in these respects. Computer technology is developing very rapidly in the provision of very large memories with rapid access, so that bibliographic data covering wide fields of knowledge can be searched for the retrieval of references pertinent to quite specific subject fields. In addition, the storing of holdings information can provide service in the locating of individual items. Services of this kind, in addition to offering higher speed of response than conventional search techniques and wider availability to all who may need them, can provide more effective, selective retrieval. The ability to store and retrieve bibliographic data including subject indexing of greater depth can lead to a higher probability of relevance of the retrieved references. Also, the storing of abstracts with the bibliographic data, where they are available, can provide an additional valuable tool in narrowing a search to the most pertinent items.

The searching service outlined here is similar to that which can now be obtained in some subject areas from indexes or abstract journals. For example, within the fields of physics or aerospace, Physics Abstracts or the International Aerospace Abstracts, respectively, may be searched with a good probability of finding many pertinent articles. However, in the proposed automated system there are several significant advantages: the search need not be limited to specific disciplines or missions where indexes or abstract journals are available; a single multi-discipline data base will be available, rather than separate sources for various subject fields; use of the system is not limited to those who have direct access to bibliographic tools; and the data base which is being searched can readily be kept up to date.

The Role of the State Library

There is ample evidence that the librarians in the State are willing to cooperate in plans of this general type, as far as their staff levels permit. What appears to be needed is coordination of effort and leadership at the state level which is now being afforded by the State Library Committee with the support of the Connecticut Research Commission and by the efforts of the State Library Research Advisory Committee and other committees at this level. In addition, it is to be expected that, sometime in the future, the automated State Center will become a component of a national library system. A conceptual design for such a system has been developed by Meise[15], and the Federal Government is tackling the subject from various viewpoints; for example, in science and technology, COSATI[16] is investigating the coordination of information networks at the national level. In this respect, coordination with planning at the national level is important, and in particular the automation plans of the Library of Congress[17] (in which UACSC is actively involved[18]) should be watched carefully.

The role of the state in providing adequate public library service has been specified in some detail in publications of the American Library Association. While in the 1956 publication, "Public Library Service"[19], services which should be performed by the state are spelled out in general terms, a revision of this document now being drafted[20] is more specific. Reference is made to the need for state level leadership in the development of a state resource center, of processing centers, central bibliographic services and in the sharing of resources and the support of research. Another ALA publication[21] offers further support on this subject, particularly in the areas of bibliographic and reference resource sharing, the need for bibliographies and indexes of state materials, and for interlibrary communications. The Connecticut State Library is currently preparing a plan for Statewide library service[22], incorporating the Research Center as one of many proposed services.

It is obvious that the establishment of a sophisticated, broad-based, automated State Center, with aims such as those described herein, will not be inexpensive. Funding must be provided, at the state level, at least for the central equipment and a communications network. Furthermore, the long-term benefits which may be anticipated should not be expected to manifest themselves in the form of reduced budgets at either the state or local level. They will appear, less obviously but perhaps more vitally, in the form of far more effective utilization of human resources, among both the librarians and their patrons, as a direct result of the broader and more efficient utilization of the available informational resources within the State. In particular, at the professional level where human resources are the most valuable, especially in the many fields of research, the chances of duplicating effort can be reduced, the probability of finding pertinent references can be increased, while less time need be wasted on both searching for and reading materials which turn out to be irrelevant. At the individual library, it is anticipated that the available professional staff members will spend more of their time performing the tasks for which they are trained, and that duplication of effort among libraries will be reduced. As an example of the latter the cataloging of a single book perhaps one hundred times within the many libraries of Connecticut can be eliminated as a direct result of the operations of the State Center. Although cataloging will not be a primary function of the Research Center, the results of the cataloging which must be done in preparing the Center's data base, either within the State or retrieved from external sources, will be immediately available to any library in the system.

The relationship between various library activities at the state level should be kept in mind. The primary purpose in establishing a State Library Research Center in Connecticut is to make a knowledge of the informational resources of the State readily and rapidly available to all who may need them, and in particular to those engaged in research activities. Closely related to this objective are other activities being planned by the State Library.[22] Where automation is being contemplated in one activity, namely the Research Center, full advantage should be taken of the availability of this capability in the provision of other library services. The centralized control of bibliographic processing is a prime example, particularly in view of the fact that cataloging data represent a necessary input for the functioning of the Research Center. Other functions, such as acquisitions and circulation control, are not as closely related to Research Center operations. Although they could provide direct input to the files of library holdings, their automation should probably be considered as longer range objectives of the overall State Library Plan in view of economic and personnel problems which would result from trying to achieve all objectives in the initial phases of the program. In any case, in the interests of optimum service and greatest economy of human and financial resources, coordination of planning effort is essential, and the extent to which central facilities may be shared should be fully investigated as the State Library Service program progresses. It is clear that the Research Center and the other services proposed are closely related and complement each other. While the Research Center will be principally concerned with determining the existence and location of library resources within the State, the other services will assist in making these materials readily available to all users, and in generally improving the standards of library service throughout Connecticut.

Report Organization

In the remainder of the report, Section 3 examines the needs of the users for services of various kinds, and sources of substantiating information including opinions expressed by a cross-section of potential users in the State, statistics of library holdings, publication rates, and patterns of the use of library resources. In section 4, a design concept for the objective operational system is described, with emphasis on the general characteristics of the proposed configuration and the ways in which it will alleviate the problems of librarians and their patrons. The procedure through which an initial system will be implemented and operated and the early service which will be offered, are covered in Section 5. Section 6 presents planning data which include estimates of anticipated equipment costs, personnel and space requirements, both for initial implementation and for the operational system of some five years hence. An outline of the study and design tasks which are to be performed in the next stage of the investigative program, prior to initial implementation, is contained in Section 7, while Section 8 presents the conclusions and recommendations of the study. The references quoted in the report are listed in Section 9.

3. USER NEEDS

Types of Users

The potential users of the State Library Research Center fall into two basic groups: the librarians and the library patrons. In some instances the needs of the two groups are quite similar, while in other areas they tend to be complementary. For the most part, the needs of the librarians can be specified, at least qualitatively, by determining the problems they face in trying to provide adequate service to their patrons. Those problems which may be alleviated through the establishment of a Research Center may then be examined. The library patrons cover a very wide range of educational and intellectual levels, interests, and activities, and their needs vary accordingly. Many of their needs are not currently being satisfied in an adequate manner, and the extent to which a Research Center may offer solutions depends upon the scope of the proposed system and the services which will be furnished.

Considering in general terms the services which have been proposed, bibliographic searching will be used both by the librarians and by the patrons, although in most cases the librarians will be conducting a search as a direct result of a request from a patron. On the other hand, the locating of documents not in the collection is usually the function of the librarian. Again, the location search usually results from a patron's request, but the patron is more inclined to divorce himself from this procedure, saying that it's the librarian's job to locate the document and obtain a copy. In an automated system, if a patron is conducting a search using a console, when he has determined the documents he wants to see, it will require only a small additional step to locate them. However, he will still presumably depend on the librarian to obtain a copy. Other services which may be offered in association with the operation of the Research Center, in connection with acquisition, processing, and control of materials, will directly involve only the librarians. The benefit to the patrons will be indirect, in the form of better overall library service. Finally, the provision by the automated system of current awareness lists would be of direct benefit to the library patron.

It is important to recognize the differences between the needs of these two groups of users. As a result of the differences, different answers must, of course, be expected to questions involving the importance and value of the various services. Both groups must be considered in a survey of user needs. The ultimate aim of any library system is to provide the patrons with the best possible service. However, it is equally vital to offer every possible assistance to the librarians, since in the library system, whether conventional or aided by automation, they furnish a vital human link between the informational resources and those who wish to use them.

Differences in requirements within each user group also must be recognized. Among the librarians, the needs vary between public, academic, and special libraries, and even within these main categories of libraries, differences occur as a result of different sizes, clientele interests, and special areas of subject strength within the collection. A significant variable affecting the needs of the library patrons is educational level, particularly if the system is intended to satisfy a range of users from high school level up to those engaged in postgraduate research and industrial research and development projects. Then again, the needs of the university faculty research worker should be expected to differ from those of the industrial project director.

Sources of Data

Three primary sources of information concerning user needs have been utilized: firstly, discussions have been held with a representative cross-section of librarians in public, academic, and special libraries, and with groups of library patrons engaged in research work; secondly, statistics which are available relating to the size and use of library collections in the State and to the fields of interest of those engaged in research, have been examined; and finally, pertinent statistics, publications, and surveys relating to other geographic areas which may be expected to have library use patterns similar to those in Connecticut have been analyzed. A fourth source of data, which could yield valuable information on user needs, was not included because of time limitations, but should be given careful consideration in the next phase of the study. This would be to collect quantitative data by sampling techniques in several libraries, to determine more definitively library use patterns within the State, and to try to establish with greater certainty potential use of the proposed system.

The main objectives in studying the requirements of the potential users are to evaluate the need for an automated library center in Connecticut, to determine the specific services that should be offered to enable the librarians to do a more complete job, and to provide direct assistance to the library patrons. It is also desirable to establish a quantitative measure of the use that will be made of the various services offered by the different groups of users. There are obvious difficulties in arriving even at estimates of use statistics. Only experience in operating a system will yield reliable values, and the best approach would appear to be to let the system grow with the actual demand.

In an attempt to survey user needs from the viewpoint of the librarians, interviews and roundtable discussions have been held with representatives of the following libraries:

Academic Libraries

- University of Connecticut, Storrs
- Yale University, New Haven
- Trinity College, Hartford
- Wesleyan University, Middletown
- Rensselaer Polytechnic Institute, Hartford Graduate Center, East Windsor

Public Libraries

- Hartford Public Library
- New Haven Free Public Library
- Bridgeport Public Library
- Ferguson Library, Stamford
- Greenwich Public Library
- Norwalk Public Library
- South Norwalk Public Library
- Westport Public Library
- Perrot Memorial Library, Old Greenwich
- Darien Library
- Pequot Library, Southport
- New Canaan Library

Special Libraries

- United Aircraft Corporation, East Hartford
- American Cyanamid Company, Stamford

Perkin-Elmer Corporation, Norwalk

United Aircraft Corporate Systems Center, Farmington

The requirements have, of course, also been discussed with personnel of the Connecticut State Library, under whose guidance the study is being conducted, and with the members of State Library Research Advisory Committee (both the working subcommittee and the full committee) and personnel of the Connecticut Research Commission. In addition, discussions were held with groups of scientists and engineers engaged in research and development activities at the University of Connecticut, American Cyanamid Company, and United Aircraft Corporate Systems Center.

It is recognized that there are other groups of users which have not been included in the survey. For example, there are significant groups of users whose activities lie outside the fields of science and engineering. Furthermore, an attempt should be made in formulating the proposed system to reach prospective users who, while they may have a need for library resources in their business or other activities, at present make limited, if any, use of available library facilities. It is anticipated that the proposed services will be of value also to these user groups, and, while time did not permit discussions with such a wide cross-section of the population, it is to be hoped that their needs were adequately expressed by their librarians.

Results of the Survey

In general, the results of the survey and interviews have been encouraging, in the sense that there is widespread agreement among the library community in the State that a need exists for a centralized activity with objectives along the lines of those proposed. As would be expected, there is some difference of opinion regarding the relative priorities of the services which may be offered and the exact form which the services should take. However, there appears to be little doubt, among those with whom the subject was discussed, that an automated center can go a long way towards alleviating many of the problems that librarians now face in providing adequate service to patrons engaged in research projects and investigative activities of many kinds. A discussion of the findings is contained in the following paragraphs. They are examined from the point of view of the major services which have been considered, namely: bibliographic searching; document location and accessibility information; and centralized control of cataloging. Brief consideration is also given to reactions to proposals for other services.

Major interest centers on the extent to which the library resources of the State may be shared among the libraries. With regard to the actual movement of materials from one library to another, interlibrary loan is, of course, accomplishing this to some extent at the present time. However, in view of the general acknowledgement of the many instances where the individual library cannot satisfy its patrons' needs, present levels of interlibrary loan activity are surprisingly low. Several reasons have been advanced for this:

1. Many patrons are willing to travel to another library if they do not find what they want in the closest library.
2. In many cases patrons go directly to a library which they know has strength in their area of interest.
3. In general, the librarian has no way of knowing where a particular document may be obtained, and a "trial-and-error" search can become expensive if the telephone is used and time-consuming by mail.
4. Whereas the experienced librarian can usually make a shrewd guess as to which other library holds a particular document, this is not true in the small libraries where training and experience are limited.
5. There is some discouragement of borrowing, particularly by libraries which are hardest hit by interlibrary loan requests.
6. Most librarians are quite hesitant to impose on others, particularly when not sure whether the other library holds the required document.

A locating and accessibility service would clearly alleviate many of these problems. While the willingness of patrons to travel is to be praised, the proposed system will not eliminate the need for travel. However, travel distances (and frustration) could be reduced by prior knowledge of the wanted document's whereabouts. Interlibrary loan requests would obviously be more frequently satisfied. For example, statistics provided by the University of Connecticut Library show that, in the period July 1, 1965 to June 30, 1966, 35 percent of requests from other Connecticut libraries were unfilled. Of these, more than two-thirds were unfilled because the item was not owned while nearly a quarter were unfilled because the item was noncirculating or because of incomplete files. A locating and accessibility service could have resulted in virtually all of these requests being directed instead to other libraries which were able to supply the documents. Furthermore, the service should result in more even spreading of loan requests among the libraries, whereas at present, most requests are directed to the large libraries. Another problem which was mentioned in connection with loan requests is that, in many cases, the requesting library does not correctly or adequately identify the desired document. In this event, the lending librarian must either return the request, or do additional reference searching to correct the information supplied. Use of the proposed system in determining the location should ensure the use of correct identifications.

The proposed bibliographic searching service is also pertinent to a discussion of levels of interlibrary loan activities. Many libraries have very little in the way of conventional bibliographic control tools, and even the larger libraries are deficient in certain subject areas. Hence, if a patron comes in seeking information on a specific subject, there may be no way of satisfying the request through access to the resources of another library which has strength in that area. With a bibliographic service, including subject searching capability, available to all librarians, specific titles can be obtained together with their locations and an interlibrary loan initiated.

There is evidence that levels of interlibrary loan are increasing in the State. For example, from 1948 to 1960 loan requests at Yale University Medical Library increased from 248 to over 3000, more than half of which came from within Connecticut, which testifies to the demand for service in specialized areas. In the special libraries, where articles in professional journals and the report literature are of paramount importance, there are particular needs for locating items of this type which are not held in the library. The industrial libraries naturally tend to build strength in the major areas of interest of the company. But the breadth and interdisciplinary nature of research and development effort require rapid access to information in other areas. Also, the extensiveness of government contracting presents a need for access to government documentation, such as technical manuals, regulations, specifications and standards, and management and legal references many of which cannot be held by each library.

There is widespread agreement on the need for a locating service in Connecticut. Efforts have already started in this direction in some instances. For example, in Fairfield County there are two active groups, each of which is forming a union list of serials. The first group, composed of 17 public libraries, is principally concerned with administrative functions, and the union list will contain all serial titles held within the group. The other group, which has a business and technical orientation, consists of public, special, and academic libraries, and in addition to building a union list of technical journals, the group is pooling resources to purchase back files of relevant periodicals which are not available in the County. The resources of these groups should be exploited, as far as possible, in the proposed State system. The advantages of operating on a statewide level include the broader data base which can be offered, state level funding and the leadership and coordinating effort which the State Library can offer, the economics of centralization, and faster and more comprehensive service which a sophisticated automation program can provide. Associated with locating service, most respondents felt that accessibility information would be valuable. Whereas the experienced librarians have a good idea of which items are available for loan, or can be photocopied, this is not true in the smaller libraries. The opinion was expressed that it is much more useful to be able to find some items which are readily accessible than to know of the existence of all references in a certain subject area most of which cannot be located.

Reaction to the proposed bibliographic searching service has been rather more mixed than that to the locating and access services. However, while some concern was expressed regarding the practicality and cost of such a service, there is general agreement that bibliographic searching would have great value. The importance of being able to conduct searches through descriptors other than subject headings was stressed. For example, date of publication and corporate or institutional source or author may be valuable entry points, usually in coordination with subject headings. Some doubts were expressed towards the feasibility of pure subject searching on the basis of present lack of depth of subject indexing. This problem is fully recognized and service is proposed, as explained in more detail later, on the basis of increasing future efforts in this area, to some extent within the proposed system but more particularly in connection with professional journal and report literature at a national level, and also on the basis of coordinated searching with descriptors other than subject headings.

The potential value of centralized control and coordination of processing is widely accepted. At present, some libraries do all their own cataloging, while most catalog all documents not covered by available card services, which represents an unnecessary waste of the limited resources of experienced catalogers and also introduces a lack of standardization which will create problems in a centralized system. Among those libraries which use the Library of Congress catalog card service, there are complaints regarding the delays incurred and the cost of the service. In most cases, the Library of Congress service embraces about 75 percent of new acquisitions. Many of the libraries, particularly academic and industrial, have rather specialized needs and also skills in the area of cataloging. In the proposed system, it is felt that these skills, and also those of groups outside the State, will be exploited to the full to the benefit of all users.

Other services besides those already mentioned which might be provided by the proposed State Center were discussed with the interviewees. For example, some showed interest in building a State-supported central depository of materials not adequately covered by other libraries in the State, or even a complete central collection. However, the generally held opinion was that this idea was wasteful and represented unnecessary duplication, and that if the State was to spend additional funds on books, they should be devoted to building upon existing strength, or a "Farmington Plan for Connecticut." The latter approach would appear to be of particular value where the proposed searching and locating services would make a knowledge of these holdings available to all. The plan itself, however, is felt to be beyond the scope of the present study. In another area, the central preparation of book catalogs for the holdings of individual libraries, group of libraries, or the whole State was suggested. A service of this kind, at least on an interim basis, is discussed and proposed in Section 5. The possibility of the State operating a central ordering facility was also considered, although in general the reaction was negative. Central ordering on a regional basis, with a system such as that of the Nassau Library in New York, was felt by some to be practical. Although most libraries are getting almost the maximum discount on book purchases already, a significant saving on book preparation costs can result from a system of this kind. It can also afford an efficient source of acquisitions data for an automated list of holdings. However, as mentioned earlier, service of this kind is not directly pertinent to the aims of the Research Center and should be considered as a long-range objective of a more comprehensive automated library system.

As a result of discussions with groups of potential patrons of the system, a notable conclusion concerned the different points of view expressed by different groups depending upon the nature of their activities. Each group recognized the value of the services which can be offered, but the various users will tend to use a particular service in rather different ways. It was generally felt that bibliographic searching will be the service of greatest value, particularly to those engaged in research and development activities. A really comprehensive current awareness list, covering rather narrowly defined subject areas, would also be very useful.

Scientists engaged in highly sophisticated research projects in an academic environment tend to have fewer problems than others in keeping abreast of developments in their fields. In many cases they work in well-defined, highly specialized subject fields in which only a handful of other investigators are involved. They often correspond with each other directly, and all within the field tend to publish in one or a small group of periodicals, which of course, they all read. However, a current awareness list for their field, or perhaps for a rather wider field which embraces theirs, covering a broader base of sources, would keep them informed of items which they might otherwise miss. Also, because of the interdiscriplinary nature of most research activities, the bibliographic searching service will be of particular value when the investigator becomes involved in a problem outside the scope of his own field of specialization. The importance of making abstracts available, in association with the bibliographic reference material, was stressed, so that the content of an article can be determined in more detail than the title or subject indexing provide.

A question was raised regarding the relative value of fact retrieval systems and bibliographic reference retrieval systems. While the former systems yield specific facts in direct response to the user's questions, the latter direct the user to specific documents which may be of interest to him. It is, of course, in the latter area that the bibliographic searching service proposed herein lies. The value of the former is not questioned, and fact retrieval systems in well-defined narrow subject areas have been operated successfully. However, it is generally conceded that, where the intent is to embrace broader subject fields, and in this instance the entire field of human knowledge, effective fact retrieval is beyond the present limits of technological feasibility.

The engineer or scientist performing research or development work in industry has a rather different viewpoint. The rapidly changing needs for information relating to a wide range of missions and disciplines make the promise of a really effective and rapid bibliographic searching tool particularly attractive. The point has been reached where it is virtually impossible for the average industrial engineer or scientist to keep informed in all the subject fields and applications with which he may be involved in pursuing a particular project. Then when he moves on to the next project, his needs are likely to be substantially different from those of the previous one. Subject searching will be particularly useful, though in many cases coordination of subject terms, which may be rather general, with other descriptors such as institutional or corporate source, or author, and often with publication dates, will produce valuable results.

Library Patterns in Connecticut

Statistics relating to library operations in the State are readily available but in many cases they are not directly pertinent to the current study. However, it is of interest to examine some of the patterns which exist to the extent that they shed light on the distribution of library resources and the needs for sharing them and obtaining wider utilization. Table I shows the distribution of holdings and personnel figures for for the largest public and academic libraries.

TABLE I

THE LIBRARIES OF CONNECTICUT

1. The Ten Largest Libraries in Connecticut

Library	Type	Volumes	Staff*
Yale	Academic	4,703,876	340
Wesleyan	Academic	517,279	29
U. of Connecticut	Academic	497,285	53
State Library	Special	459,000	N.C.**
Bridgeport	Public	440,982	101
Trinity	Academic	435,000	16
Hartford	Public	398,470	103
New Haven	Public	366,067	81
Connecticut College	Academic	202,741	9
Stamford	Public	198,186	66

* Full-time equivalents **Not comparable with other entries

(Source: U.S. Dept. of Health, Education and Welfare, Office of Education, Library Statistics, Colleges and Universities 1963-64; Statistics of Public Library Systems; and American Library Directory, 24th Edition.)

2. Summary of Connecticut Libraries

Volumes	Number of Libraries (All Types)
More than 100,000	19
20,000 - 100,000	80
Less than 20,000	223

(Source: R. R. Bowker Co., American Library Directory, 24th Edition)

The entries in this table and the propulation distribution map reproduced in Figure 1 are clear indications of the well known pattern of concentration of both population and facilities in Connecticut. There is a corridor of strength which runs from the Hartford area in the north-center to New Haven in the south-center, then west along the coast into the south-west corner. The remainder of the State is comparatively sparsely populated, weak in library facilities, and would benefit greatly from a centralized facility and a communications network which would make the system readily available to all users. Even within the central corridor, there are several examples of strong libraries surrounded by areas of weakness. For example, Bridgeport Public Library has an unusually well equipped business and technology section in spite of a below-average educational level within the city. It devotes a high proportion of its staff time to supporting the needs of residents of surrounding small towns and a concentration of light and heavy industry, which themselves are poorly equipped to satisfy the library needs resulting from high educational levels. The State system will support these smaller libraries, taking some of the load off Bridgeport and allowing the latter to devote more time to the immediate needs, perhaps at a lower average educational level, of the city residents. Similarly in Hartford, it is estimated that more than half the telephone reference requests originate outside the city.

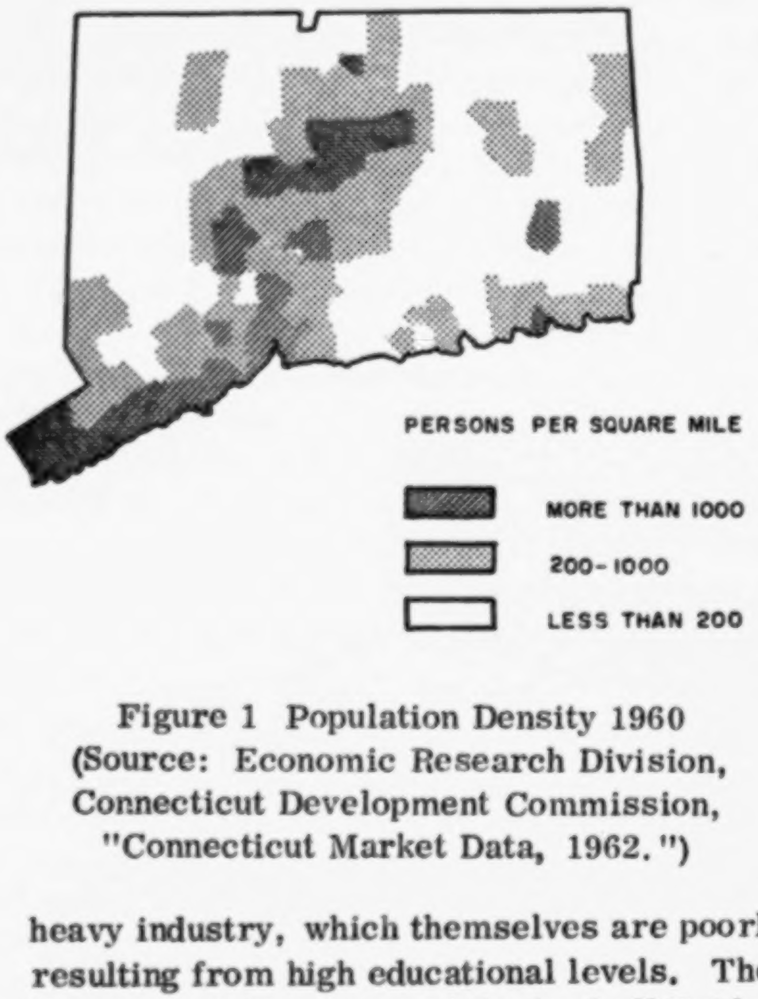

Figure 1 Population Density 1960
(Source: Economic Research Division, Connecticut Development Commission, "Connecticut Market Data, 1962.")

The development of Connecticut as a center for research is supported by data published by the National Science Foundation and the Office of Education. Although the State ranks 25th in the nation by population (1960 Census), it holds 13th ranking in terms of the number of scientists within the State.[23] Moreover, the number of doctoral degrees conferred in Connecticut in 1962 also was exceeded by only twelve other states[24] and, in graduate school enrollment, Connecticut was ranked 10th[25]. Table II shows a breakdown of scientists by field of employment, comparing Connecticut with national totals, and indicating Connecticut's ranking in each field. The table also shows the total size of the professional-technical labor force in Connecticut, and compares this with total civilian employment within the State.

TABLE II

CONNECTICUT EMPLOYMENT STATISTICS

1. Scientists by Field of Employment

Field	United States	Connecticut	Connecticut Rank
Argicultural Science	9,526	60	47
Biological Sciences	27,135	429	22
Psychology	16,804	336	15
Earth Sciences	23,417	199	29
Mathematics	20,254	379	15
Physics	26,698	610	11
Chemistry	63,053	1,424	13
Economics	12,143	207	14
Other	24,824	505	12
Total	223,854	4,149	13

(Source: Reference 23)

2. Professional, Technical Employment

Total Civilian Employment in Connecticut	990,302
Professional, Technical Personnel	127,403
Percent Professional, Technical	12.8%

(Source: U.S. Bureau of Census, as shown in Connecticut Interregional Planning Program, Report No. 132)

The data presented in these paragraphs represent an indication of present and potential library usage in Connecticut in support of research activity. They are rather inadequate in establishing a quantitative assessment of the need for a facility such as is proposed in this study. As mentioned earlier, it is felt that the techniques of statistical sampling should be applied in the next phase of the study, when more time will be available, in an attempt to arrive at a more definitive estimate of the kinds of use that can be expected when an automated centralized research center is implemented.

The Growth and Use of Library Materials

The primary aim in establishing a State library center is to provide a meaningful and effective aid to research. Those who are actively engaged in research or development effort, particularly in the various fields of science and technology, are especially concerned with the "information explosion" and their growing inability to stay abreast of new developments pertinent to their disciplines or missions. The situation is further complicated by the extensive overlapping which exists among the many fields of study.

Examples of the rapid growth of published literature relevant to research activity are not difficult to find. In the case of scientific journals alone, the annual output is approaching alarming proportions. In 1964, the National Science Foundation published the results of an investigation of scientific journals[26] which showed that, of 262 journals surveyed, only half were in existence ten years earlier and less than one-tenth were more than 60 years old (see Figure 2). The study indicated that the journal population could be expected to double every ten to fifteen years. Furthermore, it was estimated by Gottschalk[27] in 1963 that 35,000 scientific and technical journals were published throughout the world, 6,200 of which originated in the United States.

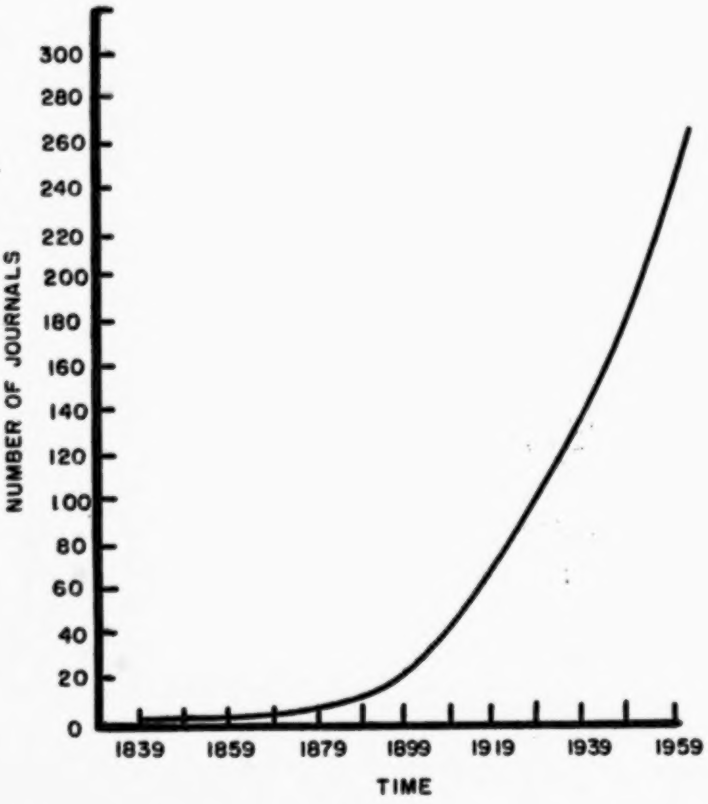

Figure 2 Accumulated Growth of Survey Journals, 1839-1959
(Source, Reference 26)

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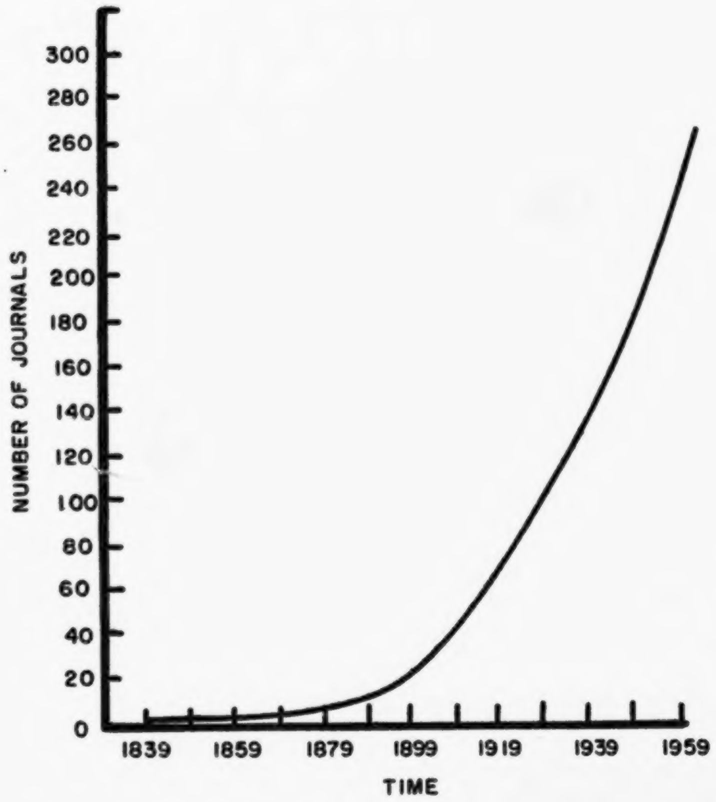


Figure 2 Accumulated Growth of Survey Journals, 1839-1959
(Source, Reference 26)

If the journals sampled in the National Science Foundation study can be considered representative of all scientific journals published in the United States, then, at an average of 126 papers per journal per year (see Table III), the annual United States output is considerably in excess of half a million papers. Table III also indicates that the average number of articles per journal per year increased 52 percent between 1949 and 1959. This increase must be compounded with the growth of journal titles.

TABLE III

AVERAGE NUMBER OF RESEARCH PAPERS PUBLISHED PER JOURNAL IN 1949 AND 1959

Discipline	Average Number of Papers Per Journal		Percentage of Change, 1949-1959
	1949	1959	
Biology (75)*	76	113	48
Chemistry (9)	293	421	44
Earth Sciences (7)	58	117	101
Engineering (5)	56	141	154
Mathematics (10)	37	58	56
Physics (8)	285	408	43
Social Sciences (25)	46	71	54
Miscellaneous (11)	36	49	34
Society Journals (150)	88	133	50
Commercial Journals (9)	63	153	35
University Press Journals (16)	42	43	8
Total (175)	83	126	52

* Number of Journals

(Source: Reference 26)

Further examples of publication growth rates are readily available. In mathematics, for example, the number of American journals increased from 1,100 in 1949 to 3,900 in 1962.[26] In the book trade, Table IV shows that 11,000 new books and editions were published in the United States in 1950. The number had risen to 28,000 by 1964. The Library of Congress, which is already committed to automation, expects to be cataloging 75,000 book titles annually in two years time, an increase of 60 percent over the present level.[28] Total new titles cataloged increased from 105,167 in 1964 to 114,875 in 1965.[29]

TABLE IV

NEW BOOKS AND NEW EDITIONS PUBLISHED

	1950	1964	Imports 1964
Agriculture	152	285	89
Art	357	906	388
Biography	603	948	175
Business	250	575	40
Education	256	1232	61
Fiction	1907	3271	110
General Works	345	532	71
History	516	1358	260
Home Economics	193	237	23
Juvenile	1059	2808	239
Language	148	801	158
Law	298	346	46
Literature	591	1454	275
Medicine	443	1211	310
Music	113	214	51
Philosophy, Psychology	340	766	131
Poetry, Drama	531	936	148
Religion	727	1830	279
Science	705	2738	678
Sociology, Economics	515	3272	528
Sports, Recreation	188	582	147
Technical	497	1125	305
Travel	288	1024	285
Totals	11,022	28,451	4,797

(Source: R. R. Bowker Co., - Publishers' Weekly)

The impact of these publication figures on the individual research worker is hard to measure, although it is clear that they must have a formidable effect, particularly on scientists whose work is interdisciplinary in nature. In connection with the Library of Congress automation studies, the King Report,[17] recognizing the difficulties inherent in arriving at a quantitative measure of user needs, noted, however, the many areas in which libraries, particularly in support of research activities, are encountering difficulties. In this regard, the report cited several areas: the rapid growth of information and attendant backlogs in processing; increasing complexity in acquisition and replacement of items; growing unwieldiness of the card catalogs; space restrictions arising from lack of awareness of marginally or totally useless items; poor response times to users' requests due to employment of manual retrieval techniques; and unnecessary duplication of effort among research libraries. The report further stated that "the present system for the bibliographic organization and display of the resources of large research libraries are not sufficiently adaptable to rapidly changing requirements, and they no longer lead the serious investigator easily and directly to pertinent information".

Overseas sources of information also are relevant in the field of technical libraries. Törnudd,[30] for example, reported that 21 percent of all researchers queried in his investigations indicated awareness of specific instances where research had been unnecessarily duplicated because information was not readily available. Moreover, the respondents to this investigation made relatively little use of library services other than loan and photocopy, perhaps an indication that technical libraries are not, in the opinion of the users, fulfilling research scientists' needs. A similarly disappointing reliance on library services was observed by Fishenden,[31] in a survey of users of a well equipped technical library, including a technical information service and bibliographic control tools such as abstract journals. He found, in a study of methods by which research workers find information, that three quarters of the useful items were found by staff members without the help of library aids. Literature searches were a very small source of information. By far the largest single source of information items, accounting for 23 percent of the total, was regular reading of current literature. It is felt that while the latter may be an excellent source of data in specific narrow fields of research, it is becoming impractical to cover the many subject fields that fall within the interdisciplinary areas of interest of most investigators by this approach.

Clearly, there is a need for substantially improving library services to the extent that research workers will have ready access to new developments in their disciplines and improved means of making retrospective searches within the significant literature. That portion of the intellectual output of the world which finds its way in document form into the libraries of Connecticut is difficult to measure at this juncture. Yet, the position of the State as a highly developed academic and industrial center leads to the conclusion that a sophisticated means for the retrieval and dissemination of resources in the form of books, periodical articles, reports, and other documents of scholarly or technical interest will greatly enhance that position.

4. THE OPERATIONAL RESEARCH CENTER (PHASE II)

The State Library Research Center must be implemented in accordance with a carefully planned, time-phased evolutionary program. In the early stages of implementation, major effort will be devoted to the development of the data base, and at least six months may be expected to elapse before even experimental service is offered. During the following two years, the data base will be growing and the service offered expanding in scope and level of sophistication. This period of expansion is referred to as Phase I of the proposed evolutionary program, and its method of accomplishment will be discussed in detail in Section 5.

At the completion of the initial implementation period, the Center will be operational, and the service offered to the users of the system should have attained all major objectives. It is this planned operational State Center, referred to as the Phase II System, which will be described in some detail in this section. As further time goes by, the service that the Phase II System provides will improve as a result of of the growth of the data base, and it will be made available to more remote users. However, except for comparatively minor refinements, the nature of the service should not be expected to change until developments at the national level occur. With the introduction of national and other regional centers, both general and special in nature, interconnected by a communications network, the level and scope of service available to the users will broaden.[15] The operation of the State Center as a component of a national system, which may be anticipated within five to ten years, is referred to as the Phase III System. The Phase III operation is not considered in any detail in this report. However, it is important to recognize at this time the likelihood of the future establishment of a national library network because of the effect such a network will have on operations within the State. In particular, because of the needs which will arise in a national system for compatability of subsystems, any attempts to establish national standards for library procedures are of significance to State level planning.

It is apparent from this brief discussion of the three major phases of the operations of the State Center that the terms Phase I, Phase II, and Phase III refer to time periods rather than different systems. In other words, it is envisioned that the same basic central equipment will be used throughout, although its storage and processing capability may be enlarged as the system expands. The reasons for this approach are discussed in Section 5. As mentioned earlier, the Phase II System may be regarded as the objective operational phase within the State of Connecticut, and it is this system that is described in the following subsections. The objective is to provide a functional description for planning purposes rather than a system design. To this end, the general characteristics of the proposed operational system are described including the services to be offered, the method of acquiring data in the center, and system scope. Also, in general terms, the methods of operation within the center and at the remote input/output locations are outlined.

System Characteristics

By 1970, it is anticipated that the State Center will be providing service to users throughout the state in public, academic, and special libraries, and possibly to other research workers not directly associated with any particular library. The data base will have been growing for more than two years and should contain reference material pertaining to all library holdings in the State which have been acquired during that period. In addition, in specific subject areas, back files covering expanded time periods earlier than the starting date may have been added.

The services which will be offered will include bibliographic searching, locating of individual items held within the State, and information regarding their accessibility to potential users outside the holding library. Also, the central control and coordination of the cataloging of all acquisitions will result in the catalog data being available to all. Further service may continue to be offered in Phase II in the form of printed book catalogs and current awareness lists.

The provision of any of these services is dependent upon the existence of an automated central catalog or file. The organization of the material contained in the catalog will be discussed in more detail later, but, in general, the content for each document will include author, title, a document number (which could be LC Card Number, Government Report Number, or other generally recognized and unique identification, or a sequence number assigned within the system), year of publication, place of publication and/or publisher, language, subject headings, and location and accessibility information. Other items which are normally found in the catalog card, and an abstract, if available, will also be stored, but probably in a separate location from the items listed above.

The effectiveness of a system for retrieving information, either in bibliographic form or in the form of locations and accessibility of documents whose identification can be specified, is dependent upon rapid response times and update capability. Therefore, the main items on which a search may be based, listed above, must be assigned to a rapid-access storage medium, and a sophisticated system of communications, including input-output terminal devices to provide an interface between the user and the automated system, must be furnished. The major elements of the system therefore may be identified as follows:

1. A large capacity, rapid-access store, and appropriate processing capability for entering, retrieving, and organizing the data;

2. A communications interface to handle a number of data inputs and requests which may arrive at the central processor simultaneously;

3. A communications network to connect the remote users throughout the State with the central processing site; and

4. Input-output terminals which furnish the user with a convenient, easily used point of contact with the retrieval system, both for entering and retrieving the stored data.

Figure 3 illustrates, in functional block diagram form, these elements and the way they are interconnected. The flow of information between the Center and the remote libraries and from outside the system is illustrated in Figure 4.

Data Acquisition

The input-output terminals, or user consoles, can be used either for entering data into the central data base or for retrieval purposes. In the operational system, it is assumed that a data base will have been established, so that, apart from possible attempts to enter back holdings from particular locations in order to increase the comprehensiveness of the catalog, the day-to-day entry needs will consist of keeping the files up to date. Each library should attempt to enter document records into the central list of holdings as they are acquired. The system can be queried to determine whether a document is already included in the central catalog. If so, catalog card sets may be ordered, and the fact that the library has acquired the document will be entered automatically into the central file of holdings. If, as a result of the initial inquiry, it is found that a document is not included in the central file, the purchasing library has the option of doing the cataloging itself and entering the data into the system (in a prescribed format), or of asking the State Center to do the cataloging or assign the task to some other library in the State.

If a procedure such as that outlined is followed by all libraries whenever they acquire new materials, the central catalog of holdings will always be up to date. Furthermore, the present costly repetition of cataloging effort among different libraries in the State will be virtually eliminated. The majority of new books will not require cataloging within the State, because of the proposed utilization of the Library of Congress MARC tapes.[32] Initially, the MARC tapes will include some 700 English language books each week, and the content and scope are expected to increase quite rapidly, so that the State Center, in taking advantage of this resource, will be able to make the content of the tapes, in card format if desired, available to any library in the State without delay. Books not included in the MARC tapes must, of course, be cataloged as at present within the State. The cataloging should be done by those most qualified, and in most cases, the procedure described above will insure this. For these less common (and in many cases foreign language) materials, the library acquiring them first is likely to be strong in the particular special field involved, and therefore is likely to have cataloging expertise in the field. Other libraries which subsequently acquire these materials need not repeat this cataloging effort.

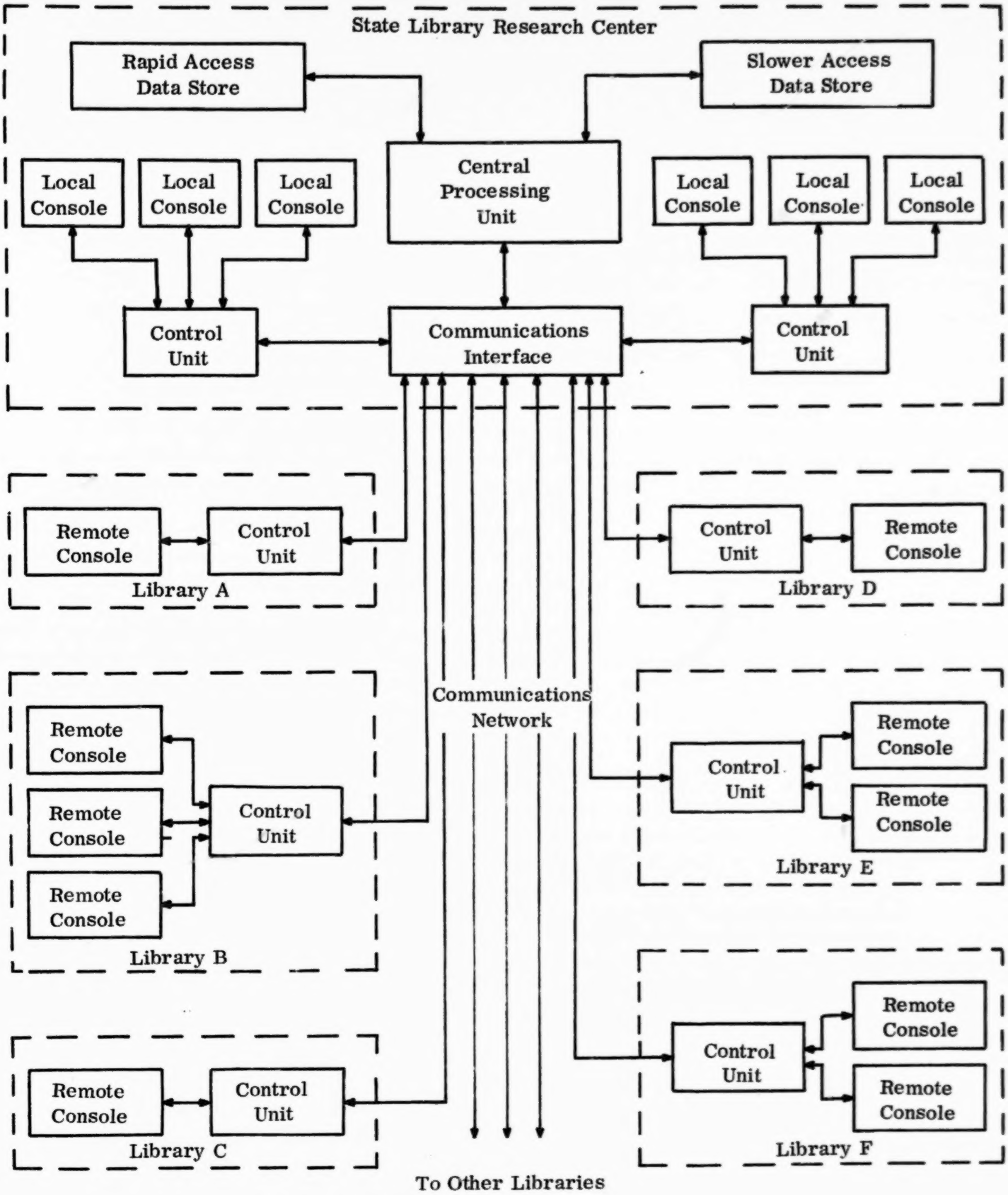

State Library Research Center
Rapid Access Data Store
Slower Access Data Store
Central Processing Unit
Local Console
Local Console
Local Console
Local Console
Local Console
Local Console
Control Unit
Communications Interface
Control Unit
Remote Console
Control Unit
Library A
Control Unit
Remote Console
Library D
Remote Console
Remote Console
Remote Console
Control Unit
Library B
Communications Network
Control Unit
Remote Console
Remote Console
Library E
Remote Console
Control Unit
Library C
Control Unit
Remote Console
Remote Console
Library F
To Other Libraries

Figure 3 Functional Diagram of State System

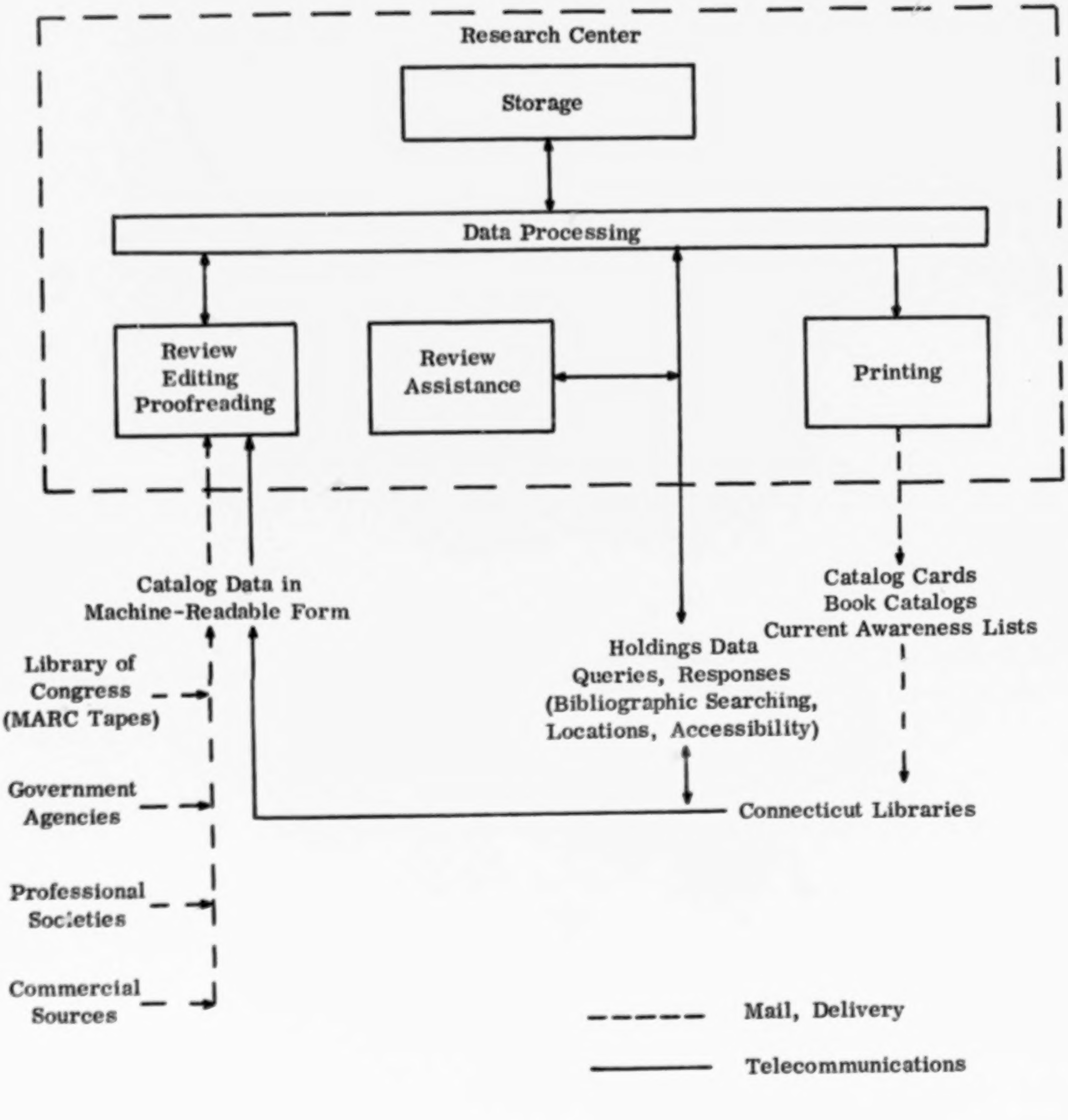

Research Center
Storage
Data Processing
Review Editing Proofreading
Review Assistance
Printing
Catalog Data in Machine-Readable Form
Library of Congress (MARC Tapes)
Government Agencies
Professional Societies
Commercial Sources
Holdings Data Queries, Responses (Bibliographic Searching, Locations, Accessibility)
Catalog Cards Book Catalogs Current Awareness Lists
Connecticut Libraries
Mail, Delivery
Telecommunications

Figure 4 Phase II Information Flow

The preceding discussion of cooperative cataloging of new acquisitions and simultaneous entry of new holdings of all libraries into the central store applies in particular to books. With regard to serial publications and report literature, special problems arise. For the State Center to offer effective service in the area of subject searching, journal articles and reports must be indexed in some depth, and this requirement is felt to be beyond the economic resources of the State. Most probably, it will be necessary to rely on the efforts of Federal Government Agencies, professional societies, and commercial concerns whose indexes are now or soon will be in a form directly assimilable by the automated Center. Considerable effort is now being expended in this respect, for example in the fields of medicine, chemistry, and aerospace, and new projects of this type are being announced with increasing frequency. The updating of periodical holdings within the State will be quite straightforward. It will be necessary only for each library to keep the Center informed of all titles on subscription order notifying when new titles are ordered or when existing orders are discontinued. In addition, the Center should be informed of missing issues or missing volumes within a set.

It is recognized that considerable effort will be required of each library if the holdings file is to be kept current and accurate. With respect to books, it would appear, without detailed analysis, that the advantages to the individual library in terms of the ready availability of cataloging data will outweigh the effort required in entering all acquisitions. For periodicals, the advantages to the library of keeping the central records complete are less obvious. But it is obvious that the proposed locating service will be effective only if the holdings file is accurate, and it is anticipated that the spirit of cooperation which exists between libraries in the State will prevail in this regard.

Data Retrieval

Returning to the operation of the user consoles, it was pointed out that the consoles can be used either for entering information into the data base or for retrieving data. In the latter area, the retrieval process can be utilized for searching out bibliographic data or for finding locations and accessibility information. The retrieval of locations and accessibility is straightforward, assuming that an adequate means of identifying the document is available. The simplest means of identification will be to use the document number. If this is not known to the searcher, author and title can be used for identification as long as this provides an unambiguous description of the document. Following the identification of the document, the user will request locations and accessibility, and these will be displayed immediately. Detailed design of the system will result in the establishment of rules for selecting the information to be displayed in answer to a single inquiry. For example, if a book is held in nearly every library in the state, the provision of a list of all holding libraries would be extravagant in terms of storage capacity and not very useful to the requestor. When more than a given number of libraries hold the book (perhaps 20 or 30) it may be sufficient to store only the number of holding libraries or the names of those out of a preselected set of 20 or 30 libraries uniformly distributed throughout the State which hold it. With regard to accessibility information, it is anticipated that one of a small set of accessibility categories will be stored along with the identification of the holding library. The categories might include "available for reference only," "available for interlibrary loan," and "available for photocopying."

If the librarian or library patron cannot completely or uniquely identify specific documents he is trying to locate, a search must be made in terms of whatever material he is able to provide. Many searches will undoubtedly start with subject headings and the effectiveness of subject searches will depend principally on the depth of subject indexing of the document records stored in the central catalog and on the efficiency and speed with which the files may be searched to retrieve those documents to which the requested subject headings have been assigned. As mentioned already, the extent to which subject indexing in depth can be contributed within the State will be limited by economic restraints. Within the journal literature, particularly in the scientific and engineering fields, it is anticipated that external sources will offer rather extensive subject indexing, and the State Center should capitalize on this resource as far as possible. With regard to books, subject indexing of items included in the MARC tapes will be limited in the immediate future, although greater depth of subject indexing may result from the Library of Congress automation study. It appears unlikely that the Center will have the resources to add materially in this respect. For books cataloged within the State, adequate subject indexing should be included wherever it is feasible. Overall, it must be conceded that during the Phase II period, subject indexing may not be included in the central catalog in sufficient depth to permit really sophisticated searching on this basis alone. It is anticipated, however, that this situation should improve as more subject indexing in depth is accomplished on a national level.

If subject indexing does not exist in depth, it is probable that a subject search will retrieve an unmanageably large list of references, and other means must be used to narrow the search. Additional limits may be imposed by coordination between the available subject headings and other descriptors. In this respect, the entry terms which may be used will include personal author, corporate or institutional author or source, date of publication, place of publication or publisher, language of publication, and possibly the fact that a bibliography or a list of illustrations is included. Then again, the search may be limited to books, journal literature, or reports. The descriptors other than subject headings, listed here, may also be used as primary points of entry into the system, rather than the subject headings. It is anticipated that this approach will be most useful where only partial reference data are available, and an adequate description of the document is needed to request location information, an abstract, or perhaps to initiate an interlibrary loan. Alternatively, the searcher may want to determine everything that has been produced within a given time period by a particular author. With regard to the coordination of search descriptors, it is anticipated that the notation of Boolean algebra, including at least the logical connectives "and" and "or," and possibly also "not," will be utilized. It may also be desirable to incorporate some means of controlling the depth of a subject search. In these respects, definition of the exact procedures must await detailed investigative effort in the next study period.

System Scope

It is felt that the objective of the State Center should be to include as wide as possible a coverage of subject fields held within the State. Although the primary aim of the Center is to aid research activity, there appears to be no valid reason for limiting the holdings to specific subject areas. It can be legitimately argued that any published literature can have an application in some field of research, and the imposition of limits would tend to have the effect of increasing human intervention in the acquisition of bibliographic data, since a choice has to be made regarding the acceptability of each item. Furthermore, where bibliographic data are acquired in bulk and accepted into the system essentially automatically (for example, the content of the MARC tapes), it would be advantageous to accept the entire content, rather than limiting acceptance to those items held within the State. With this approach, the information is in the system and ready to accommodate future acquisitions. Even though the holdings record for many items may initially be blank, if and when the item is acquired by one of the libraries, it will only be necessary to add the holdings data to the record. In addition, even if the item is never purchased by a library within the State, a knowledge of its existence may very well be useful to some user making a bibliographic search.

Center Operations

The operation of the Center may be discussed in terms of the principal functions it performs: namely, the acquisition of new data, and the retrieval of stored data. The details of these operations, including the requirement for human review of inputs, program design, file organization, kinds and size of storage media, and data processing procedures will be determined in the next phase of the design study. At this stage, however, the general functional requirements can be indicated. It should be emphasized that procedures outlined herein are subject to revision as a result of more detailed design and analysis.

Data Inputs

The sources of bibliographic data relating to new acquisitions will be the MARC tapes, other similar sources for journal articles and reports (for example Federal Government Agencies, professional societies or commercial organizations offering service of this kind), and sources of catalog data within the State, including the larger libraries and the Center itself. For the first two, it is assumed that the information will be available in machine readable form. From within the State system, entry of bibliographic data will be effected by means of consoles, either within the Center or from remote libraries.

It is anticipated that each document record accepted into the system from external sources will require human review. For this purpose, the record will be entered from the source (usually magnetic tape) into working storage and displayed on the editor's console for review, editing, and addition of items if necessary. These steps will be performed by use of the console keyboard. Independent proofreading is desirable, and for this purpose the edited record can either be transferred to the proofreader's console, or printed by a high-speed line printer.

The product of cataloging efforts within the State will be the same as that described for external source data. In this case, however, the cataloger will generate the bibliographic document record on the console, either in the Center or at a remote library. On completion, the record will be entered into working storage, and review and proofreading will proceed as before.

When the document record has been proofread, it is ready for entry into the permanent files. The record will be structured in such a way that the items required for entry into the rapid-access retrieval files can be extracted automatically. In this way the author and title will be extracted and merged into the author/title file, and against each entry the document number will be recorded. Conversely, in the document number file, the author and title will be entered, and also other items which may be used for retrieval, such as date of publication, publisher and/or place of publication, language, and possibly the fact that a bibliography or a list of illustrations is included. In addition, the subject headings will be added to the document number file, and the document number will be entered under each appropriate term in the subject file. The content and organization of the files will require detailed study, and approaches other than that outlined here should be considered. For example, Kessler[33] reports successful results using citation coupling for retrieval of references from the physics literature. It would appear, however, that the breadth of subject coverage in the proposed system would make this approach less effective.

It is important to note that the permanent files which constitute the data base of the system must be protected against inadvertant (or intentional) alterations, additions or erasures. To this end, the system will be designed in such a way that only designated consoles in the Center may be used for the authorization of file updating. In other words, while the update information may originate from other consoles, either remote or local, the designated consoles will be the only ones from which actual entry of the data into the files can be initiated. Special authority codes for data entry, a knowledge of which is strictly limited to designated members of the Center staff, may be used as an additional safeguard.

The catalog data that are not required for retrieval purposes, and the abstract, if one is available or generated, will be entered into a separate store, probably with slower access time. The most suitable storage medium and the procedures to be followed in this respect will require detailed study and economic analysis. However, it appears relatively certain that an attempt to store all these data in the rapid-access retrieval files would unnecessarily add to the cost of the system and degrade retrieval performance.

The printing of catalog card sets at the Center, to satisfy the needs of the remote libraries, represents a valuable by-product of the primary function of entering cataloging data into the system. It is anticipated that rapid service can be offered. The problems associated with differences in card requirements among the various libraries are fully recognized, particularly regarding cards for subject cataloging. Detailed study of the needs must be made, but it is felt that, in view of the vastly improved speed of service compared with that currently available (for example from the Library of Congress), it will be possible to arrive at acceptable compromises regarding card formats and content.

In addition to the bibliographic data records for each document, library holdings information must be acquired. As outlined above, with the cooperation of all the libraries, the holdings data will arrive at the Center at the time the documents are acquired, enabling the locations file (which will store locations information against document number) to be kept current. For libraries with consoles, acquisition of a document will be entered automatically from the remote location. Other libraries must notify the center of acquisitions by mail, telephone or Teletype (if available), and the data will be entered into the locations file through use of one of the Center consoles.

Data Searching

Queries arriving at the Center from remote consoles will first be subject to an automatic review of their acceptability to the system. If they are unacceptable, the requestor will be notified by means of an automatically generated message. He may then rephrase his request, or ask for the services of a Center staff member who will monitor the ensuing dialog on a center console, making suggestions where necessary.

(The use of a small number of Center staff members in this manner may be considered a function of training library personnel in the operation of the system. As experience at the libraries increases, the need for this service will diminish.)

When an acceptable query is received, the required information will be extracted from the appropriate files, formulated into a response message with the necessary address and control data to assure receipt by the requestor, and entered into an output buffer for transmission. Associated with the search procedure, there will be a logging function to keep track of request originators, types of requests and responses, response times, and possibly estimates of the quality or usefulness of the response. The results of this accounting procedure may be reviewed automatically and periodically printed out for use in system evaluation and improvement studies.

For libraries or other remote users who do not have consoles, mail or telephone must be used for communicating with the Center. In this case, a Center staff member will use a local console to enter the query and receive the response, so that internal operation will be the same as described above. If mail is being used, the entire dialog can be printed by a Center printer for mailing to the requestor.

Equipment Considerations

The equipment requirements may be broken down into central computing equipment with bulk storage and other peripherals, a communications interface, communications circuits, and remote consoles. Some general comments on each are included in the following paragraphs.

Central Equipment

A typical configuration for the central equipment complex is illustrated diagrammatically in Figure 5. While no attempt has been made at this stage to select specific manufacturers or models, it appears from preliminary estimates of processing volumes that the IBM System/360 Model 50 would be appropriate for the central processing unit. This conclusion is based on past experience in comparable design projects, and on the requirements in this system for multiple access by a large number of users and the need for rapid internal operations to provide fast access to stored data. There are, of course, other manufacturers whose equipment could satisfy the requirements. Those which may prove to be more suitable include the Scientific Data Systems Sigma 7 and General Electric 645 processing systems. A duplexed configuration is shown in Figure 5 to provide more efficient operation, and also to allow for continued service during scheduled or unscheduled maintenance periods. Under normal conditions, each computer and its peripherals could be performing similar tasks. For example, the communications circuits could be equally divided between the two. Alternatively, one computer could be used for communications processing, and the other

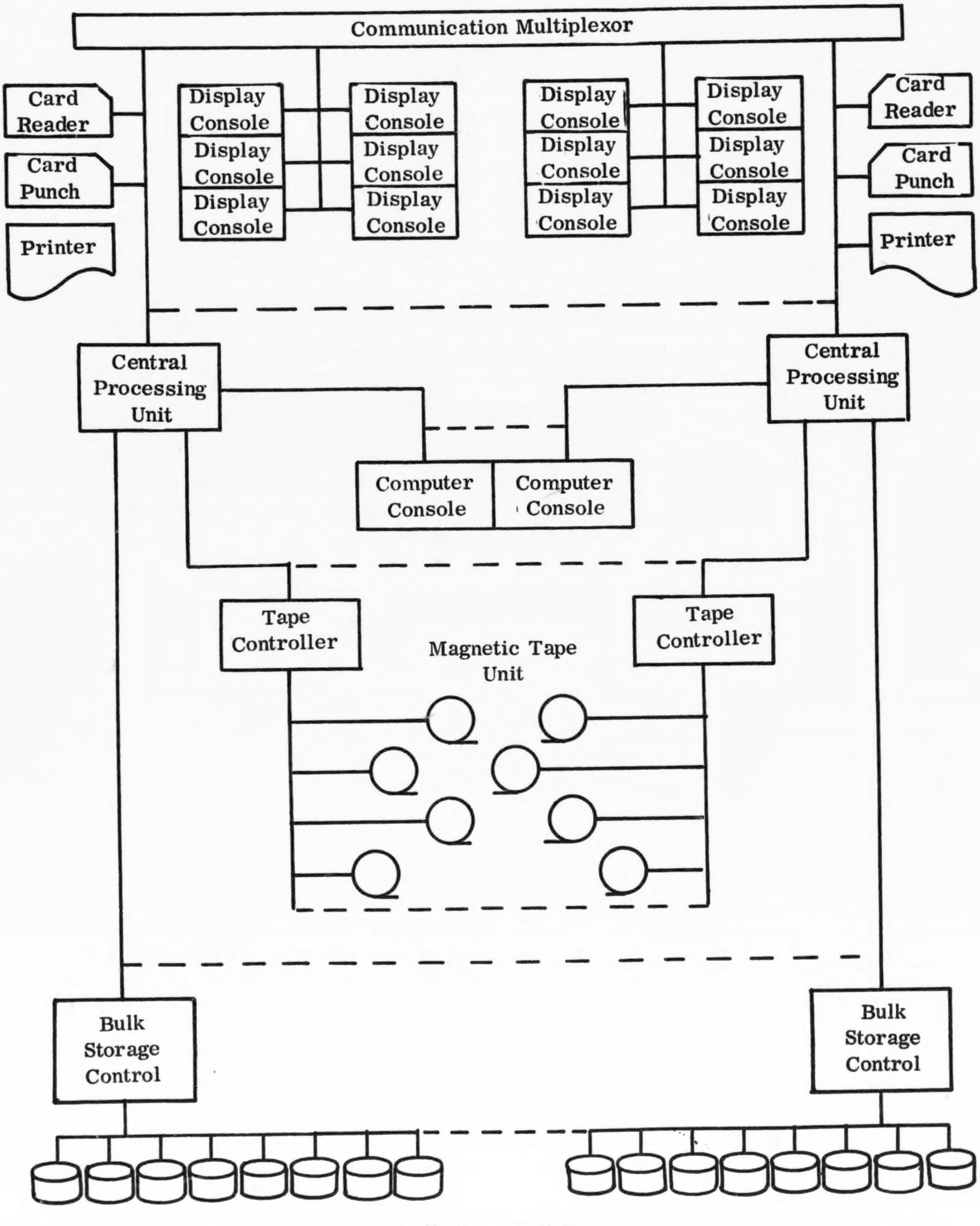

Communication Multiplexor
Card Reader
Card Punch
Printer
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Card Reader
Card Punch
Printer
Central Processing Unit
Central Processing Unit
Computer Console
Computer Console
Tape Controller
Magnetic Tape Unit
Tape Controller
Bulk Storage Control
Bulk Storage Control
Bulk Storage Units

Figure 5 Phase II Central Equipment Configuration

for data entry and retrieval. Under normal operation, the primary data flow lines (solid lines on Figure 5) will be in use. During scheduled maintenance on one of the computers, or in the event of a breakdown, the secondary data flow paths (broken lines) will permit the other computer to carry the entire load, with a minor deterioration in performance in the form of slightly longer response times.

Associated with the central processing unit will be a large volume rapid-access memory, probably in the form of disc storage data cells. The active files used for bibliographic retrieval purposes will be stored in the rapid-access memory, and it is estimated that an average of some 500 alphanumeric characters of storage capacity will be needed for each document. When the system is first implemented, the new acquisitions will amount to some 30, 000 book titles per year from the MARC tapes. The annual growth rate will increase rather rapidly as other sources are added, particularly journal articles and reports, and by the end of five years there may be 500, 000 or more document records stored in the system. For the Phase II system, some 400 million characters of random-access storage is included, which allows for 800, 000 document records.

Slower access storage, perhaps using magnetic tape, also will be needed, for storing other bibliographic information and abstracts. Also, as time passes, it will become necessary to transfer some of the active file data to the slower access store, particularly in science and technology where growth rates are highest. Fortunately, in these fields information is comparatively perishable, and only the more recent information is needed frequently.[34]

A number of consoles will be required in the Center, for review and entering of acquisitions data, monitoring and assistance in the conducting of searches, and checking system operation. A requirement of 12 display consoles for library-type personnel has been estimated. The control units which will be needed in association with the consoles are not shown, since the configuration depends on the choice of a manufacturer and model. In addition, card punches and readers will be needed, principally for program loading, and high-speed line printers for the hard copy output requirements of the Center, which may include the printing of book catalogs, current awareness lists, and catalog cards for distribution to the libraries.

Communications Interface

The communications interface, or multiplexor, serves the purpose of accepting the input messages from the multiple lines of the communications network, temporarily storing them, and feeding these messages in sequence, at the higher computer speeds, on one or more channels into the central processing unit. Also the multiplexor performs the reverse function of accepting at high speed the output messages from the central unit, again temporarily storing them, then transmitting them on the correct line, according to the address, at the lower transmission speed of the communications circuits.

Communications Network

The communications network will consist of a large number of voice-grade circuits joining the communications interface at the Center with the remote consoles in the libraries. Figure 6 illustrates a typical network for connecting the Center, assumed to be in Hartford, with 74 of the larger libraries in the State. The lines are grouped in such a way that advantage may be taken of lower Telpak tariffs on the full-time leased circuits. A transmission speed of 1,200 bits-per-second will probably be sufficient, and half-duplex service should be adequate. Further analysis studies should, however, be conducted to determine the possible economic advantages of 1,800 bits-per-second asynchronous transmission, at a slight increase in the cost of line terminating equipment, or 2,000 to 2,400 bits-per-second synchronous service at appreciably higher terminating cost. The higher speed of transmission will probably not be needed unless a party-line configuration, with perhaps 10 consoles sharing a line, is considered. Resolution of these problem areas in advance of implementation is dependent upon accurate statistics of usage. Then a straightforward queueing analysis can be performed, if necessary using a simple computer simulation model. In view of the difficulty of arriving at reliable usage statistics, it is possible that modifications in the communications design will be necessary as operating experience is gained. Minor changes in configuration or transmission speed can be made quite readily, without seriously affecting other aspects of system operation.

User Consoles

At the remote libraries, and in the Center, consoles of the keyboard input/cathode ray tube display appear very desirable. At least 8 manufacturers are selling devices of this type in the comparatively low-cost class.[35] A good example is the Sanders Model 720 Communications Terminal, with a display capacity of 1,000 characters, excellent editing features which permit insertions and deletions without retyping, and off-line composition. Upper and lower case font capability is essential, and while none of the commercially available low-cost consoles of this type offer this feature at present, it almost certainly will be added, at reasonable additional cost, by some of the manufacturers, including Sanders, in the near future. Control units are required in association with the consoles, and in most cases several consoles may share one control unit, so reducing the average price per console. Since this feature is less of an advantage in a library system, where there are many libraries which can justify only one console, than in some other applications where the consoles are in clusters, the relationship between console and control unit costs is an important consideration.

The requirement for hard copy printouts at the remote libraries must be investigated. Printers can be installed in conjunction with the consoles, but the cost is rather high. There may be a need for recording the visual displays on the CRT screen

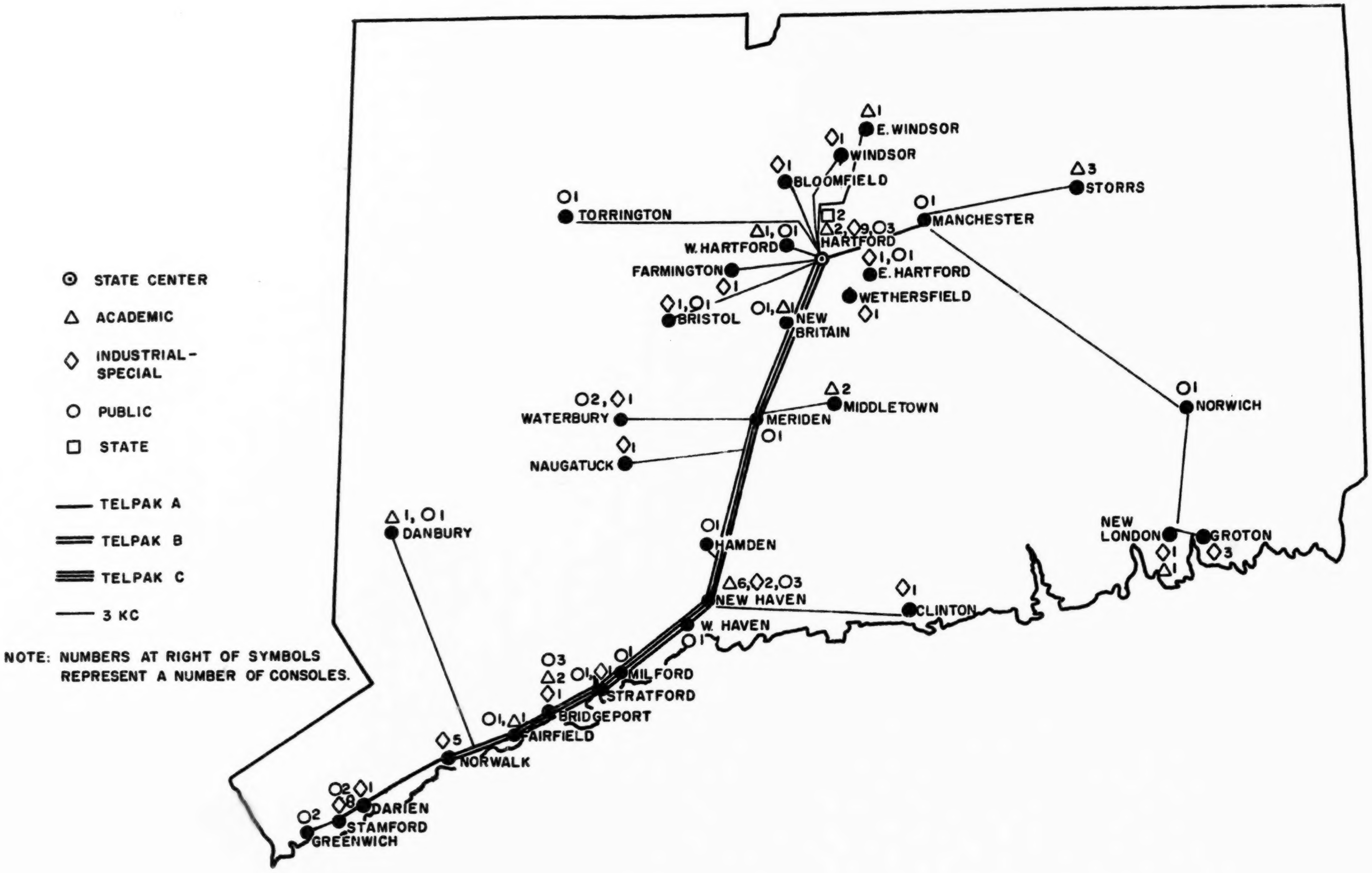

⊙ STATE CENTER
△ ACADEMIC
◇ INDUSTRIAL-SPECIAL
○ PUBLIC
□ STATE
TELPAK A
TELPAK B
TELPAK C
3 KC
NOTE: NUMBERS AT RIGHT OF SYMBOLS REPRESENT A NUMBER OF CONSOLES.
△1 E. WINDSOR
◇1 WINDSOR
◇1 BLOOMFIELD
△3 STORRS
○1 TORRINGTON
□2 △2,◇9,○3 HARTFORD
○1 MANCHESTER
△1, ○1 W. HARTFORD
◇1,○1 E. HARTFORD
FARMINGTON ◇1
WETHERSFIELD ◇1
◇1,○1 BRISTOL
○1,△1 NEW BRITAIN
○2, ◇1 WATERBURY
MERIDEN ○1
△2 MIDDLETOWN
○1 NORWICH
◇1 NAUGATUCK
△1, ○1 DANBURY
○1 HAMDEN
NEW LONDON ◇1 △1
GROTON ◇3
△6,◇2,○3 NEW HAVEN
◇1 CLINTON
W. HAVEN ○1
○3 △2 ◇1 BRIDGEPORT
○1,◇1 STRATFORD
○1 MILFORD
○1,△1 FAIRFIELD
◇5 NORWALK
○2 ◇1 DARIEN
◇8 STAMFORD
○2 GREENWICH

Figure 6 Communications Network Connecting 74 Major Libraries

of a bibliographic listing, and for a low cost alternative to the printer, a Polaroid-type camera might prove satisfactory. On the other hand, the larger libraries may desire local capability for printing catalog card data transmitted from the Center, and a high quality printer, with upper and lower case, would be needed. At least for the smaller libraries, it is anticipated that card printing will be centralized, with distribution by mail or other delivery service.

User Dialogs

One of the major problem areas in establishing a bibliographic retrieval system is the selection of a query language that gives the relatively inexperienced user the ability to interact freely with the automated system. The users of the remote consoles will include librarians and, to a lesser extent, library patrons. The task of training the librarians in the use of the system will be an appreciable one, and the feasibility of allowing patrons to use the consoles themselves will be highly questionable, unless a simple language and a set of almost self-explanatory instructions are developed.

It seems unlikely that consoles could be installed in open library areas, where any member of the public would have immediate access to them. However, there are significant advantages in allowing library patrons who make frequent and serious use of the system to conduct dialogs themselves. In this way, the librarian can save time, and the patron has the advantage of direct interaction with the stored data, allowing him to utilize the information presented at each stage of the search in formulating the next question. Only he knows exactly what he is looking for, and the results are more likely to be pertinent, and the search will converge more rapidly, if he has direct access to the console. In most cases the librarian will have to conduct the search, but discretion should be used in deciding which patrons are capable of and can benefit most from operating the consoles themselves. In this regard, several investigators have examined dialog problems and the extent to which relatively inexperienced users can operate retrieval consoles without the help of an intermediary.[35,36,37]

The descriptors used for bibliographic retrieval must be entered and displayed in full, except perhaps for standard abbreviations of words like "journal," "proceedings," "university," journal titles, and possible use of short titles. On the other hand, a structured set of commands of limited number can be abbreviated in mnemonic form to save time and simplify the query procedures. For example, LOCT for "locate," BIBT for "bibliographic tree" (a list of authors who have published on a given subject, and number of publications by each) and ACCS for "accessibility information" are possibilities. The language would define all the operations which the user would require the system to perform in conducting a search.

An example is given in Figure 7 of a sample dialog between a user and the system. It is a simplified case intended for illustration only, and the actual procedures are likely to change as a result of more detailed design of the system. In particular, the structure of the central files will be the subject of a detailed investigation in the next phase of the study, and opinions of experienced librarians will be sought in determining the most useful descriptors for search purposes and the form in which they should be stored. The results of these studies, and also of early experience during the Phase I period, will obviously have a direct impact on the structure of dialogs in the operational system.

	USER QUERY	COMPUTER REPLY	MEANING
1.	J. Jones, U Conn		User identification and location
2.	VOCB: Computer Search		What is the correct term to use for locating information about computer searching methods?
3.		Data Storage-Retrieval	
4.	VOCB: Coupling		
5.		Bibliographic coupling Electrical coupling Mechanical coupling	Three types of coupling are available.
6.	BIBT, 1965: Data Storage-Retrieval and Bibliographic Coupling		Provide bibliographic tree of authors who have published on both subjects in 1965.
7.		Display A 1. J. A. Doe (2) 2. R. P. Smith (1)	J. A. Doe wrote 2 articles & R. P. Smith wrote 1 in 1965.
8.	List: A1		List the 2 references of the first item of Display A.
9.		Display B 1. Doe, J.A. The Design of a Library Information System, International Conference on Scientific Information, 1965 2. Doe, J.A., Bibliographic Coupling in Library Data Retrieval, University of Manitoba Symposium on Library Sciences, 1965	List of documents as requested
10.	LOCN: B1, B2		Where are the documents listed in Display B?
11.		B1: SCSC, Trinity, Yale U B2: Not held in Connecticut	
12.	ACCS: B1		What is accessibility status of the first item of Display B?
13.		B1: Available for photocopy	
14.	STOP		End of Dialogue.

Figure 7 Sample Dialogue

5. IMPLEMENTATION OF THE PHASE I SYSTEM

A brief discussion of the three major phases of the plan for the State Center, extending over a period of five to ten years, was included in the introduction to Section 4. A plan for the timing of the first two phases of the program is illustrated in bar chart form in Figure 7. The time scale shown on the figure is based on the assumption that funding will be available for a July 1967 start. Phase I of this program, roughly covering the period from July 1967 to the end of 1969, represents the initial implementation and preliminary operation of the system. By 1970 the system should be operational, and by a process of evolution the major objectives should have been met. At that time the objective operational system referred to as Phase II should be in existence. In the following paragraphs, the steps involved in traversing this initial Phase I period will be described.

July - December, 1967

In July 1967, as a result of detailed design effort starting in September 1966, equipment for the initial centrally located facility will have been selected, and orders can be placed. Deliveries may then be anticipated early in 1968. In the intervening period of six months, there are several planning tasks which should be conducted. During the preceding design phase a survey will have been conducted to determine sources of pertinent catalog data in machine readable form. Starting in July 1967 it will, therefore, be possible to obtain these materials on a regular basis, and, where necessary, to prepare them for immediate entry into storage in the new equipment when it is delivered. If conversion of these data into a format suitable for entry into the proposed system is required, the programs for conversion will be written, and the actual conversion can be accomplished by using any available computer installation. The extent to which preparation of catalog data in this manner will be possible will not be known until the data sources are studied in detail. However, it is felt that every effort should be made to build a data base of bibliographic material as rapidly as possible. In addition to assembling materials for inclusion in the data base, considerable effort will be devoted to design of the computer programs for initial operation of the system, and to actual computer programming. The programs may also be tested on an available computer installation.

In the initial months of the program, it is likely that the prime source of data will be the MARC tapes from the Library of Congress. Starting in July 1967, they may be acquired directly from the Library of Congress, or through Yale University which is to be a recipient in the pilot phase of the MARC project starting in the fall of 1966. A library of the tapes can be built up in advance of delivery of the Center equipment, and some processing of the data may be possible during this advance period. One of the problems of building the data base in the Phase I period of Center operation will be acquiring of information concerning the holdings of libraries throughout the State. Information of this kind could be collected manually, and prepared for machine input, in conjunction with the building of the MARC tape library. A method of achieving this, subject to further analysis, would be to obtain a reproducible printout of a title/author listing of the content of each MARC record. Duplicated copies of this list could be mailed to each library in the State, and, within a reasonable period (perhaps two months) the library could return the list with the acquired items checked. The resulting holdings information could be manually collated and entered into a machine readable record, probably on magnetic tape, for entry into the Center equipment data base when the equipment is delivered. This procedure would continue until the installation of remote consoles in the libraries permits automatic acquisition of the holdings information. (An alternative approach, which will be considered, is to disseminate the MARC data on punched cards, asking the libraries to return those cards which correspond to books they have acquired. The others could be kept, and sent in if a book is acquired later.) It might also be feasible to acquire additional holdings information, beyond the scope of the MARC tapes, by asking the individual libraries to enter identifying information, at the end of each list, for other items which have been acquired. In addition to offering a means by which holdings may be entered into the system during Phase I, the circulation of these lists would probably provide a useful tool to the libraries in their process of book selection. Also, as soon as the Center has a means of preparing catalog cards from the MARC tape data, duplicated cards could be distributed to the libraries on the basis of the acquisitions data contained in the returned book lists. As a result, an earlier start than would otherwise be possible would be made on allowing the libraries to benefit from the central source of catalog data.

January - June, 1968

Assuming a six months delivery time, the central equipment should be installed in January, 1968. In addition to the central processing unit and peripheral processing equipment, a small number of input/output consoles and a high speed line printer will be required at this time. As soon as the equipment has been installed and checked, the building of the data base of bibliographic references can start. The availability of a small number of keyboard/cathode ray tube consoles will facilitate the entry of items which are not contained within the MARC tapes or other external sources in machine readable form. The data required within each record will be typed on the keyboard, and will be immediately displayed on the tube face for proofreading and editing. When each item has been reviewed and proofread, either on a console screen or through a printout, the record will be entered into the computer store, where it will be processed and organized within the various files in accordance with the data entry programs, as described in Section 4 for the Phase II system. With regard to the items contained within the MARC tapes, and other similar sources, the extent to which individual records will require editing and proofreading before entry into the files must be determined by detailed analysis in the next phase of this study. This latter comment applies to both the records prepared before delivery of the central equipment, as described above, and to the records for items acquired on a continuing basis.

During the first few months after delivery of the central equipment, as the stored data base starts to grow in size, effort can be initiated on the testing of the retrieval programs on an experimental basis. For this purpose, requests will be made on one of the consoles when it is not being used for entry of data, and the responses will be displayed either on the console or on the output printer.

July, 1968 - June, 1969

After the files have been building for some six months, in mid 1968, the first service, which will be rather restricted in nature can be offered to users either at the Center or at remote libraries. The first service will be limited by the size of the data base, and by the limited capabilities of the central equipment in the early stages of operation. Queries from remote locations will have to be forwarded to the Center by mail, telephone, or Teletype. If the experimental Teletype network which was recently installed in eleven Connecticut libraries is still in service, either in its present form or on an expanded basis, it would offer a convenient means of entering queries and distributing responses. In this event, human intervention and transcription for entry into the automated system would probably be required, but the possibility of direct input and direct readout of responses should be investigated. The requests which are processed by the central equipment will probably be handled in batches, and initially it is anticipated that overnight service will be offered. For the more complex inquiries, such as subject-oriented searches, personnel at the Center having a detailed knowledge of the form of the data base and the programs in use will be required to formulate the requests into a language acceptable to the system. It is also desirable that the requests be phrased in such a way that meaningful results will be obtained as a result of a single pass through the system, reducing the need for multiple attempts to arrive at the desired answers, which would lead to excessive response times in a batched-processing operation.

During the period of some two years after the first restricted service is offered, the capability of the system will gradually be expanded. By adding sophistication to the central equipment, such as more rapid access storage media (for example, discs replacing magnetic tapes), response times will be reduced and it will become possible to replace batched searching with on-line service. At this time, communications interface equipment will be added to the central site, and it will be possible to install user consoles in some of the remotely located libraries. In this manner the system will evolve, rather slowly, from what has been described as Phase I operation to Phase II.

During the Phase I period of operation, before the installation of a communications network and remote consoles, the extent to which the system can offer effective service will be limited. It will be advantageous to offer service in printed form, such as book catalogs covering the new acquisitions content of the data base, or current awareness lists in specific subject areas. Further study will be needed to determine the feasibility and potential use of these services. The book catalogs could cover the new holdings of individual libraries, groups of libraries (grouped either geographically or by type of library) or for the whole State. A union catalog in this form would probably be superseded, in Phase II, by on-line request service for locations, at least for those libraries with consoles. However, for an extended period it is realistic to suppose that not all libraries will have consoles, and it may be desirable to continue the printing of catalogs for their benefit. The current awareness lists would probably be most valuable in specialized scientific and technological areas, and it may well prove worthwhile to continue this service indefinitely. The printing of catalog cards which will be a continuing product of the Center, also should be started as early as possible.

Phase I Equipment

The equipment required in Phase I will be evolving throughout this period. An example configuration, which might represent the system towards the end of Phase I, is shown in Figure 9 for illustrative purposes. It is felt that, even though a smaller central processing unit might accommodate the needs of Phase I, it will be advantageous to start the program with equipment that will still be adequate after a number of years. Peripheral equipment will be added as the project develops, but no extensive reprogramming will be needed. Unlike the Phase II period, at this early stage of operation duplexing will not be justified. Bulk storage will be provided, either in the form of magnetic tape or discs, or (as shown), a combination of the two. Six consoles are shown for data entry, data review and local retrieval. Punched card equipment will be used for program loading, and a high speed line printer for providing the printed services and other uses such as entry proofreading.

Phase I - Phase II Transition

The latter part of Phase I will be a period of evolution, both in terms of central equipment and services offered. In actual fact, there will be no clear-cut division between Phase I and Phase II. As shown in Figure 8 design and development effort for the Phase II system will start during Phase I, and on-line services such as those described in Section 4 may be offered to a small group of users whenever the equipment is available. Also, the Phase I services must be retained well into the Phase II period to accommodate libraries which do not have remote on-line consoles. The overlap of these activities and services is indicated by broken bars in Figure 8. For the request service, response times will gradually improve as the system develops. Initially, delays of several hours, or overnight must be expected. By the end of Phase I, however, the central equipment should be capable of response times measured in seconds, and as the remote consoles are installed through the Phase II period, more and more users will be able to take full advantage of this rapid-access capability.

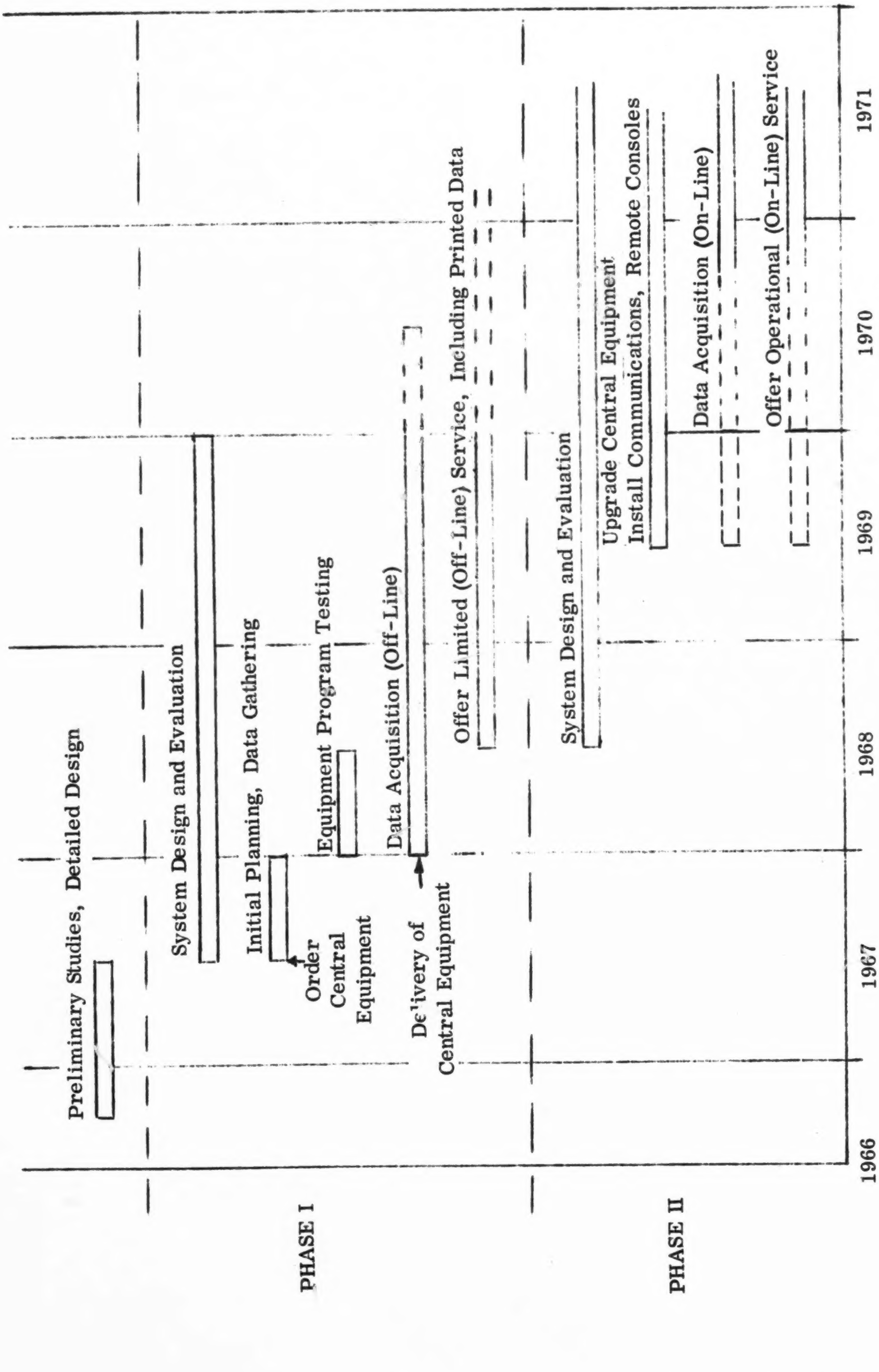


Figure 8 Implementation Program

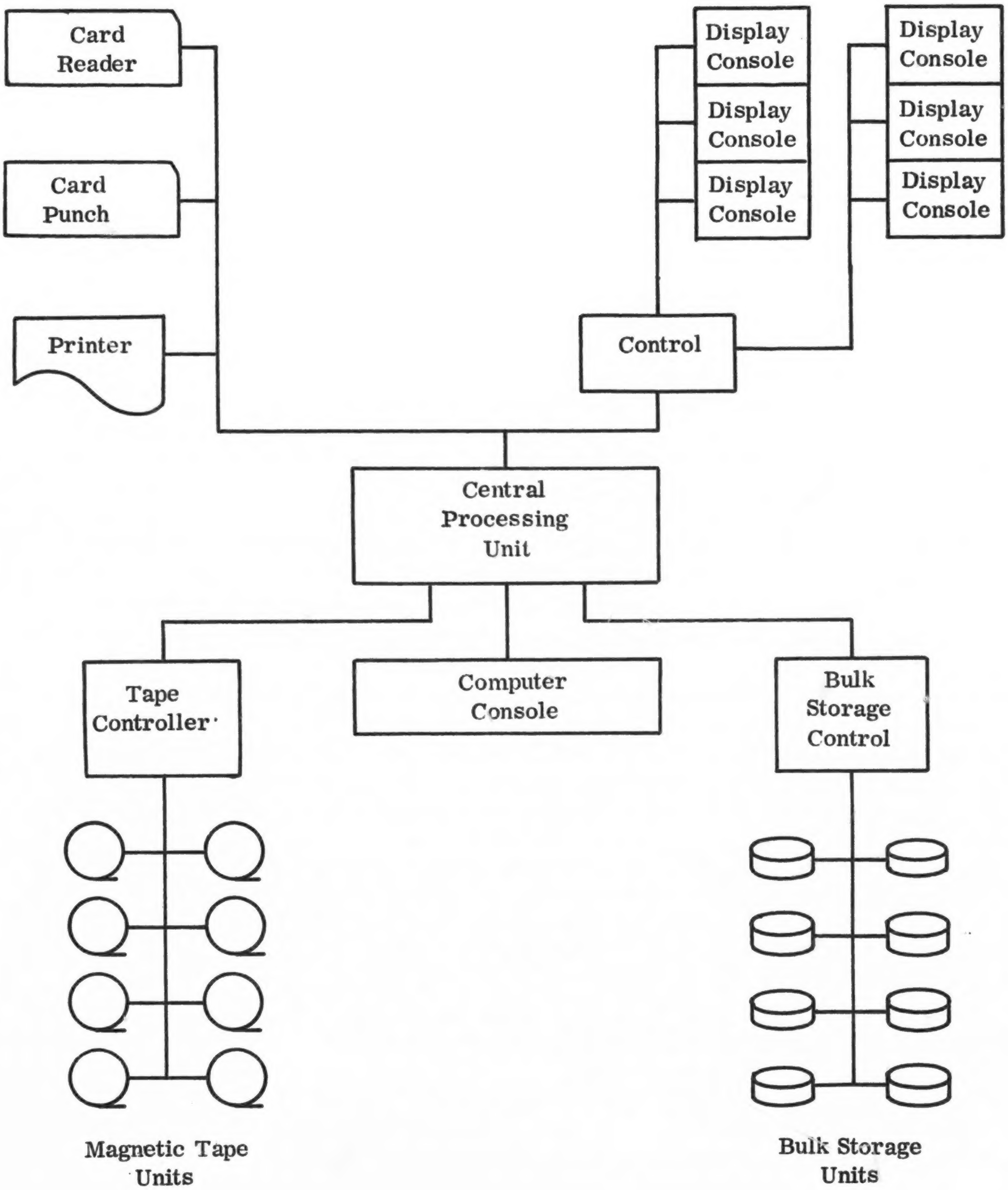

Card Reader
Card Punch
Printer
Display Console
Display Console
Display Console
Display Console
Display Console
Display Console
Control
Central Processing Unit
Tape Controller
Computer Console
Bulk Storage Control
Magnetic Tape Units
Bulk Storage Units

Figure 9 Phase I Central Equipment Configuration

6. GENERATION OF PLANNING DATA

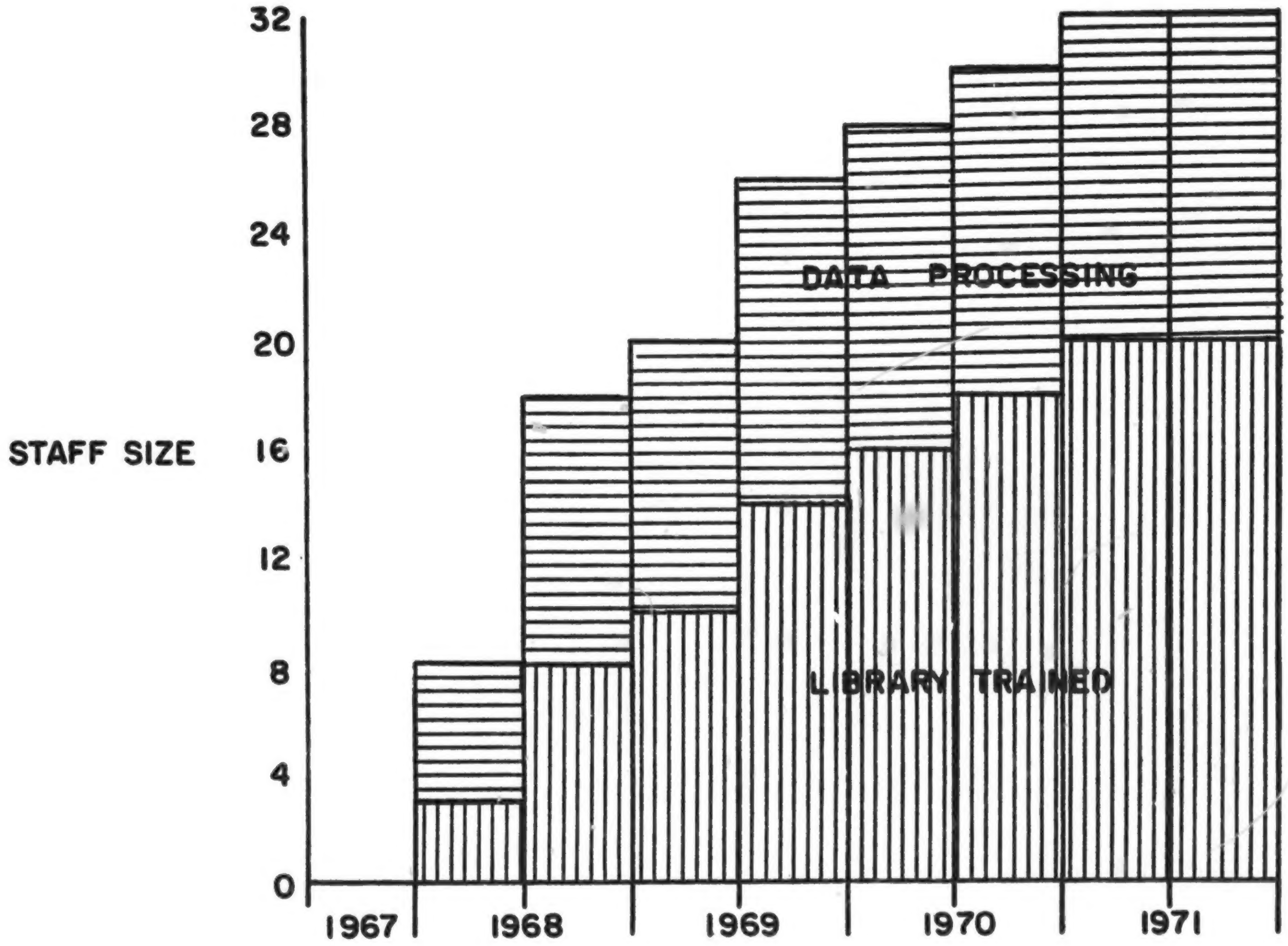
For the purpose of planning the implementation and operation of the proposed State Library Research Center, estimates of equipment costs, personnel requirements, and space needs have been generated. It must be emphasized that all the numbers presented in this section are estimates, intended only for planning purposes, and they must be refined and substantiated by detailed design and analysis studies in the next phase of the program.

The equipment configurations presented are intended to aid in arriving at realistic cost estimates. They do not constitute endorsement of specific equipment vendors, nor do they imply that the indicated configuration represents an optimum design. However, it is believed that the general configurations shown do represent a practical means of accomplishing the stated objectives. All prices are based on rental from the manufacturer with maintenance included. In addition to the requirement for central equipment, in Phase II the costs of the communications network and remote consoles are included. It should be noted that the possibility exists for recovering a part of these costs by charging some of the customers (for example, industrial libraries) either for service or perhaps for console rental.

The requirement for personnel is divided into two categories in accordance with the basic function performed: system implementation and system operation. The implementation staff members will be required for system planning, design, evaluation and improvement, as the program develops, and also for programming and checkout of equipment. There will be a continuing need for implementation staff, because for the foreseeable future the system will be growing in scope. However, the size of this staff will tend to fluctuate, and in view of this fact and the specialized skills involved, it may prove advantageous for the State to make use of contractor assistance in this area. The operations staff will include librarians for review and editing of data inputs and for monitoring requests for data, and data processing personnel in connection with the operation of the central equipment. In the operations area, the initial requirements will be small, then the need will grow steadily as the system expands, leveling off after some five years.

The requirements for implementation and operations personnel are shown, for both Phases I and II in Figure 10. To indicate in general the distribution of required skills, at each stage of the program, the numbers of people needed for operation of the system are divided according to those with skills in librarianship or in data processing. It should be noted that not all those in the librarian class need be professional librarians. Although the specialized skills and levels of training needed have not yet been evaluated in detail, there will be a need for assistants with some library experience but not necessarily with graduate level qualifications.

Systems Operations Staff



System Implementation Staff

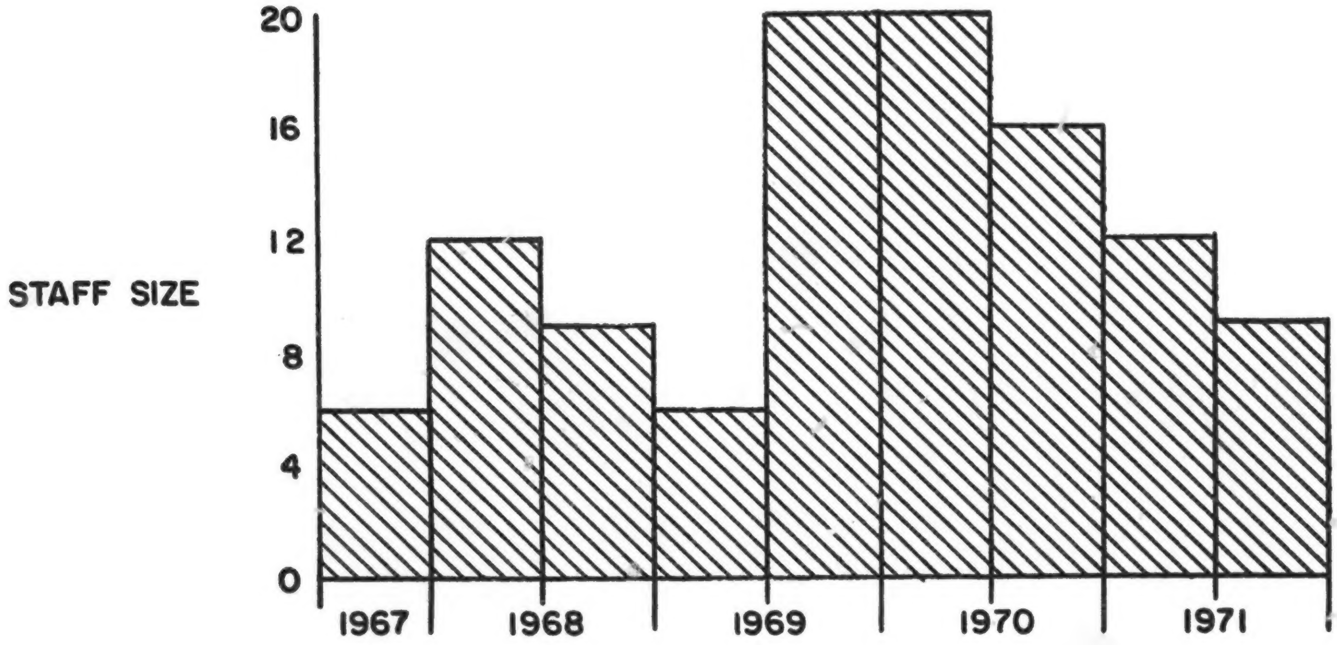


Figure 10 Personnel Requirements

Space will be needed to house the central equipment and all personnel required at the Center location. The space must be air conditioned in accordance with equipment manufacturers' specifications. The question of the location in the State of the Center has not been studied. The advantages of proximity to the State Library in Hartford, at least from the point of view of administration, are obvious. From equipment cost considerations, the only factor of relevance to a choice of location would be communications line costs, and in this respect, the effect of changing the location would be negligible in comparison with the total system cost. The approximate space needs will be 7,000 square feet during Phase I and 10,000 square feet during Phase II.

The discussion of equipment costs, which follows, is divided into the Phase I and Phase II periods of the proposed program. The final chart incorporates both phases, to illustrate the overall growth in cost levels as the system evolves.

Phase I Equipment

The central equipment configuration for Phase I was shown in Figure 9. As discussed in Section 4, a central processing unit of the approximate size and capability of the IBM System/360 Model 50 will be needed in Phase II, and this model is used also in Phase I for costing purposes on the basis of avoiding reprogramming costs and the disruption of service associated with a drastic change in central equipment. The control unit and associated peripheral equipment items, including magnetic tape and bulk storage units, are shown with the associated monthly rental costs in Table V. Also shown are the costs of the consoles for the Center personnel based on use of the IBM 2260 Communications Terminal. Consoles of other vendors have certain features which tend to make them more attractive, but their use introduces an additional requirement for an interface unit. For the present purpose, costs are based on the IBM unit.

Since a phased implementation program is proposed, not all items will be acquired at one time. To begin with, there will be about a six months' delivery period at the start of Phase I during which there will be no Center equipment. During the latter part of this time, it is planned to make use of other computer installations for data conversion and other planning tasks. A total cost of $40,000 has been allocated for this purpose. During the following 18 months, the Center equipment will be added as shown within the six-month increments of Table V. Allowance has been made for more than one shift of operation during this period to accommodate contingencies which usually arise during the implementation of a new system, and also for generating the printed products. (It should be noted that overall efficiency is increased by operating more than one shift, because of the substantial discount on the rates for time after the first shift.) Summarizing the costs shown in Table V, to total equipment cost for the first year will be $173,000, and for the second year $314,000.

TABLE V

EQUIPMENT COSTS - MONTHLY RENTAL - PHASE I

Equipment	July-Dec 1967	Jan-June 1968	July-Dec 1968	Jan-June 1969
Central Processing Unit				
IBM 360-50 Computer with 65,556 bytes		$ 10,040	$ 10,040	$ 10,040
Tape Equipment				
Tape Controller				
8 Tape Units, IBM 2401-II 60 kc instantaneous rate		5,250	5,250	5,250
Card and Printer Equipment				
Control for card and printer units				
Card Reader/Punch IBM 2540 1000 cpm/300 cpm				
Printer IBM 1403 Estimated at 400 lpm with upper and lower case		2,810	2,810	2,810
Supporting Equipment		416	416	416
Display Equipment				
Control				
6 Display Units			720	720
Bulk Storage				
Control and IBM 2411 Data Cell				5,250
Total monthly rental (one shift)		$ 18,516	$ 19,236	$ 24,486
Estimated cost for operation after the first shift		3,620	3,764	4,814
Estimated cost for use of other computer installation	$ 40,000			
Total cost per month		$ 22,136	$ 23,000	$ 29,300
Total cost per six-month increment	$ 40,000	$ 132,816	$ 138,000	$ 175,800

Phase II Equipment

In Phase II, as in Phase I, the central equipment will be expanded gradually as the additional capacity is required. It is anticipated that the first remote on-line display consoles will be installed in the second half of 1969, and, thereafter, some 20 consoles will be added each six months. At this rate there will be 100 remote consoles by mid 1971. To accommodate the extra load on the central equipment, the working storage of the first computer will be doubled in 1969, and the second computer allowing the duplexed configuration will be installed in 1971. The peripheral equipment items, bulk storage, and display consoles at the Center also will be increased as the demand rises.

To provide an on-line connection between the remote consoles and the central equipment, the communications interface, or multiplexor equipment will be installed on an incremental basis, and the communications circuits will be added as needed. With regard to the remote consoles, it appears at this stage that the Sanders 720 terminals have distinct advantages over the IBM units (for example, promised availability of upper and lower case letters, off-line editing capability, and lower cost in single-unit installations), and the cost estimates are based on Sanders prices. However, use of these consoles will require a special interface unit at the Center, and an estimated monthly cost for this unit is included. The necessary inclusion of this item to permit use of Sanders consoles in the remote libraries makes it advantageous also to use them in the Center.

In order to estimate the cost of communications for the Phase II period, and also to give an indication of likely remote console distribution on the State at that time, a brief study of the larger libraries in the State was performed. Included were the industrial libraries listed in the 24th edition of the American Library Directory, academic libraries serving institutions with graduate programs, public libraries serving populations over 30,000, and the State Library. More than one console was allocated to the largest libraries, and one voice-grade circuit was provided for each library, with a maximum of three consoles per circuit. The results are summarized in the following tabulation:

Type of Library	No. of Libraries	No. of Consoles	No. of Circuits
Industrial	40	40	40
Academic	13	21	14
Public	20	29	20
State	1	2	1
TOTALS	74	92	75

The 20 public libraries, while constituting less than 10 percent of the State total, directly serve some 1,380,000 people, or 54 percent of the State's population, according to the 1960 census. Figure 6 shows the locations of the libraries, the numbers of consoles, and the communications network required to connect them to the State Center in Hartford.

Taking full advantage of the Telpak tariffs for bulk communications rental, the circuit charges for this network will be $3,800 per month. To this must be added the monthly rental for terminating equipment at each end of each voice-grade circuit, amounting to another $6,000 for a total of $9,800 per month.

The monthly rental costs for the individual items, for each six-month increment of Phase II, are shown in Table VI. Summarizing the equipment costs for Phase I and Phase II, Figure 11 shows the total equipment cost for each six-month increment from July 1967 to December 1971.

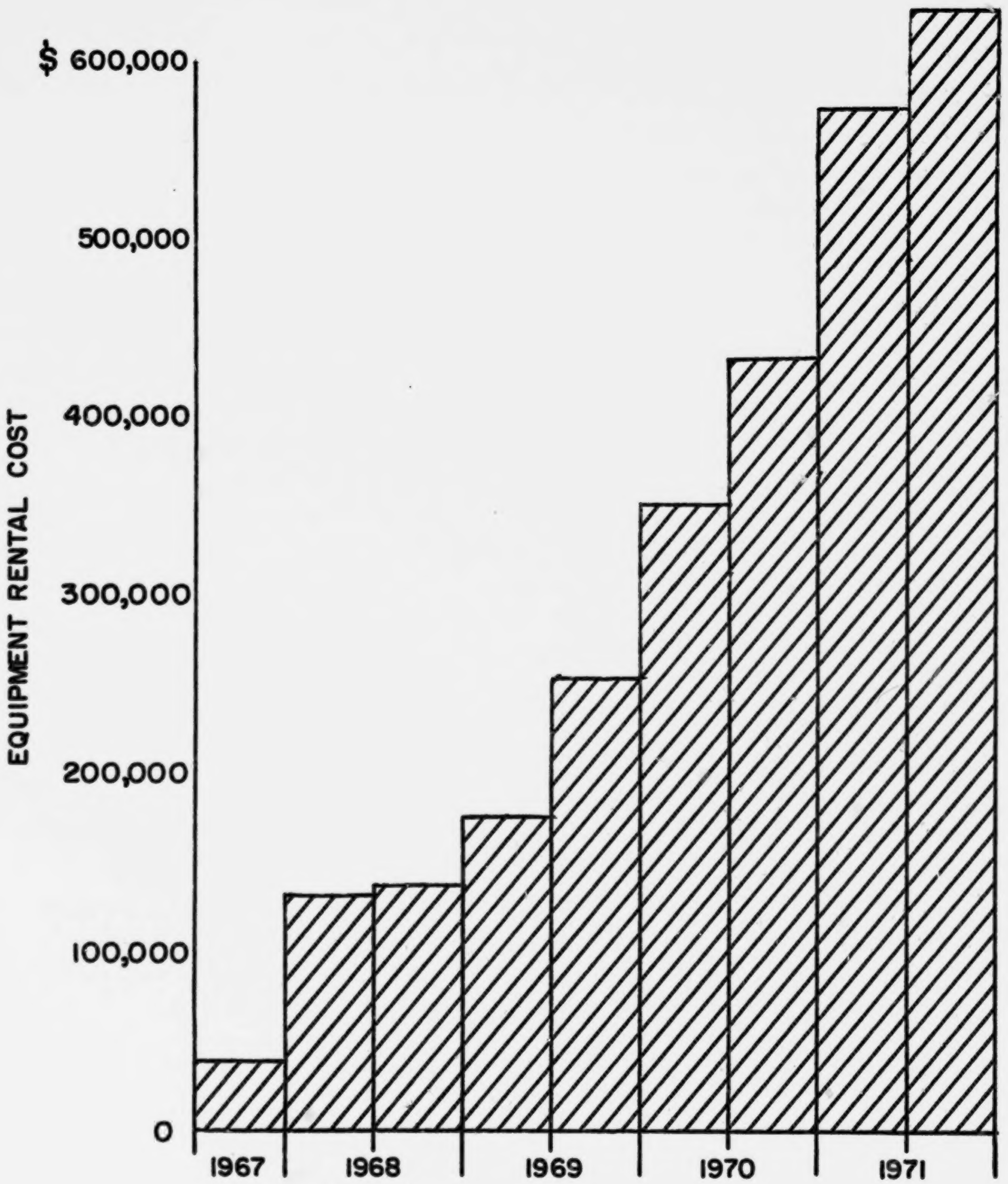


Figure 11 Total Equipment Rental Cost by Six-Month Increments

TABLE VI
EQUIPMENT COSTS - MONTHLY RENTAL - PHASE II

EQUIPMENT	July-Dec 1969	Jan-June 1970	July-Dec 1970	Jan-June 1971	July-Dec 1971
Central Processing Unit					
1 IBM 360-50 Computer with 131, 072 bytes	$11,640	$11,640	$11,640		
2 IBM 360-50 Computers with 131, 072 bytes plus channel to channel adapter				$23,505	$23,505
Tape Equipment					
1 Tape Controller, and	5,250	5,250			
8 Tape Units, IBM 2401-II, 60 kc instantaneous rate					
2 Tape Controllers, and			6,500	6,500	6,500
8 Tape Units, IBM 2401-II					
Card and Printer Equipment					
1 Control for Card and Punch Units, and	2,810	2,810			
1 Card Reader/Punch, IBM 2540, 100 cpm/300 cpm, and					
1 Printer, IBM 1403					
2 Controls for Card and Punch Units, and			5,620	5,620	5,620
2 Card Reader/Punches, IBM 2540, and					
2 Printers, IBM 1403					
Supporting Equipment	416	566	566	566	566
Display Equipment					
12 Display Units (IBM and Sanders)	1,620				
6 Display Units (Sanders)		900			
8 Display Units			1,200		
10 Display Units				1,500	
12 Display Units					1,800
Bulk Storage					
1 Data Cell, IBM 2411, 200 million characters	5,250				
2 Data Cells, IBM 2411, 400 million characters		10,500	10,500	10,500	10,500
Communications Interface					
5 Data Adaptor Units, IBM 2701 (4 lines)	2,150				
10 Data Adaptor Units, IBM 2701		4,300			
15 Data Adaptor Units, IBM 2701			6,450		
20 Data Adaptor Units, IBM 2701				8,600	
25 Data Adaptor Units, IBM 2701					10,750
Remote Display Equipment (Estimated)					
20 Display Consoles	3,000				
40 Display Consoles		6,000			
60 Display Consoles			9,000		
80 Display Consoles				12,000	
100 Display Consoles					15,000
Special Interface Unit	3,000	3,000	3,000	3,000	3,000
Communications Network and MODEMS	2,000	4,000	6,000	8,000	10,000
TOTAL MONTHLY RENTAL (One Shift)	$37,136	$48,966	$60,476	$79,791	$87,241
Operation after first shift (Estimated at 20%)	7,427	9,793	12,095	15,958	17,448
TOTAL MONTHLY RENTAL	$44,563	$58,759	$72,571	$95,749	$104,689
TOTAL PER SIX-MONTH INCREMENT	$267,378	$352,554	$435,426	$574,494	$628,134

7. OUTLINE OF TASKS FOR NEXT STUDY PERIOD

In accordance with the proposal submitted by United Aircraft Corporate Systems Center to the Connecticut Research Commission, dated May 6, 1966, additional studies will be performed during the period September 16, 1966 to July 31, 1967. The specific tasks to be performed will include at least the following:

1. Detailed Design of Phase I System

Detailed information will be generated concerning the design and operation of the central facility during the Phase I period of implementation. Included will be the configuration of the central hardware and software, the design of the central files and the data processing procedures.

2. Examination of Data Sources

A closer examination of all feasible sources of bibliographic data in machine readable form will be conducted. In particular, conversion problems associated with the Library of Congress MARC tapes will be studied. In addition, other sources of data, presently available or planned for the near future, will be surveyed, particularly with relation to acquisition of journal article reference data. A refinement of estimates of total data base size and growth rates will be a byproduct of this task.

3. Thesaurus Requirements

The problems associated with providing a Thesaurus of subject terms will be studied, including consideration of the most desirable form and format (for example, printed versus machine stored, alphabetic versus hierarchical). The associated requirements for computer review of inputs and queries and for authority lists will also be examined.

4. Preliminary Data Acquisition Planning

The extent to which bibliographic and library holdings data can be acquired in advance of delivery of the central equipment will be studied. Plans for initial acquisitions and conversion programs will be formulated, including the use of other available computer installations where feasible.

5. User Requirements

Studies will be performed incorporating statistical sampling techniques to determine in more detail holdings and use patterns in libraries in Connecticut. In particular, the extent of overlap in library holdings is of interest in evaluating data base size, and user areas of interest and extent of use are of interest in estimating potential usage values.

6. Detailed Planning Data

Estimates of costs, personnel requirements and space needs for the Phase I system will be refined. In conjunction with the results of Task 1 above, this will permit the generation of a detailed implementation plan.

7. Survey of Other Systems

A survey will be conducted of other systems with objectives comparable to this one, to determine the extent to which advantage may be taken of experience gained in other similar environments.

8. Assist in Preparation of Legislation

Assistance will be provided, as required, to the State Library in the drafting of material that can be presented to the State Legislature in January 1967.

The outline of tasks presented here is intended principally for planning purposes. They may be modified in content or new tasks may be added within the funding and manpower restraints, as the need arises.

8. CONCLUSIONS AND RECOMMENDATIONS

As a result of this preliminary study of the proposed Connecticut Library Research Center, several conclusions have been reached and recommendations can be made. Further detailed study is needed, as outlined in the preceding section, to provide additional substantiation and refinement of the results. However, it is felt at this stage of the study that the conclusions are of sufficient validity to justify proceeding with the plans for implementation of the Center and, in particular, to justify the program as proposed.

Conclusions

1. A need exists for a Connecticut Library Research Center aimed at improving the speed and completeness in locating and making available the informational resources of the State.

2. The services which should be provided by the Center include bibliographic searching, a document locating service with associated accessibility information, and centralized control, coordination, and dissemination of catalog data.

3. Additional service in the form of printed book catalogs and current awareness lists should be provided at least in the early phases of the system.

4. The present state-of-the-art in computer technology and communications make a system such as that proposed immediately feasible. Developments expected in the next five years are likely to increase capability and reduce costs.

5. Assuming that funding is available to start implementation of the proposed system in July 1967, the funding and personnel requirements for the first two years will be:

Annual Equipment Costs		Personnel (Full-time)	
		Operation	Implementation
1967-68	$173,000	8	9
1968-69	$314,000	18	8

6. During the first two years of operation, an area of 7,000 square feet of air-conditioned space will be required.

7. During the Phase II period of operation, the annual cost is estimated at $1,010,000 with a personnel requirement for 30 full-time employees for system operation and 14 for implementation, and a requirement for 10,000 square feet of air-conditioned space. These needs should apply in the year 1970-1971.

8. The attitude of enthusiasm and cooperation shown within the library commuity of Connecticut will enhance the probability of success in operating a system of the kind described.

Recommendations

1. The State should proceed with detailed planning for a phased program of evolutionary implementation of a Library Research Center as described in this report.

2. Funding for the initial phase of the program should be sought with the objective of starting implementation in July, 1967.

3. In preparation for initial implementation in July, 1967, the study program described in Section 7 of this report should be completed by that date.

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